AN EXAMINATION OF ONE-TO-ONE TECHNOLOGY APPLICATIONS AND PEDAGOGICAL STRATEGIES IN A MIDDLE SCHOOL MUSIC PROGRAM

by

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ABSTRACT

An Examination of One-to-One Technology Applications and Pedagogical Strategies in a Middle School Music Program

Loren McCready

One-to-one computing programs, in which every student in a school is issued a device (e.g., iPad, Chromebook), are rapidly becoming ubiquitous within many educational environments. The technological resources that one-to-one programs provide afford teachers a multitude of opportunities to implement innovative pedagogical approaches in their classrooms and adopt more student-centered practices. The purpose of this single case study was to identify uses of one-to-one technology in an exemplary middle school music setting. The participant taught sixth, seventh, and eighth grade band classes in addition to a seventh grade general music course. He was selected on account of his extensive integration of technology within his classroom. The study examined the variety of digital tools and resources he utilized and their pedagogical applications. Data were generated through two interviews with the participant, observations of seven class periods, and collection of digital artifacts. The participant demonstrated substantial use of technology in his instruction, and his students regularly applied their one-to-one devices in the music-making process. Analysis of the data revealed that the teacher used technology to assess students, differentiate instruction, increase student engagement, encourage musical creativity, support autonomous learning, and collaborate with colleagues. This was accomplished using a variety of applications, such as Canvas, GarageBand, Google Slides, Notability, TonalEnergy Tuner, and YouTube. Each of the

applications served a clear pedagogical purpose and helped the participant reach his goals and objectives in each of the observed lessons. The participant expressed that the school's one-to-one technology program has enhanced his teaching approaches and has expanded curricular possibilities within the music program.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

Chapter 1: Statement of the Problem

Rationale

The pervasive nature of technology in contemporary society has presented new and exciting opportunities, as well as many challenges, within the field of education. The effective incorporation of digital learning into classroom environments is now an aspect of teaching that must be continually examined. Technology integration provides a multitude curricular possibilities that promote student-centered environments which emphasize autonomous and flexible learning (Bassett, Franey, Horsley, McKnight, O'Malley, & Ruzic, 2016; Cremata & Powell, 2017; Ward, 2009; Williams, 2017). However, while personal technology consumption is now ubiquitous in modern culture, research of its specific pedagogical applications is inadequate in many teaching contexts, especially within music education (Bauer, 2012; Bauer & Dammers, 2016; Dorfman, 2008).

Williams (2017) claims that "the music education profession in the United States has not embraced technology…there are music teachers who have embraced technologies in their teaching and learning environments, but this simply isn't true for the vast majority of our profession" (p. 1). Within music education, teaching methods remain largely traditional and are generally slow to adapt to current educational trends, particularly in regard to use of technology (Colwell, 2002; Cremata & Powell, 2017; Erickson, 2012; Wise, 2016). Many findings have suggested that this may in part be due to lack of technological training in preservice teacher education programs (Bauer, 2012; Bauer & Dammers, 2016; Gall, 2013). It is critical that these programs address the rapid

advancement of digital teaching and learning to prepare future educators for the widespread adoption of technology initiatives in schools (Abbitt, 2014; Williams, 2017). Bauer and Dammers (2016) found that only 33% of preservice training programs offer a technology course that is specifically designed for music education majors. In order to adapt to rapid changes in the current educational landscape, both current and preservice teachers should continually consider how to integrate technology as a core component to their instruction.

The TPACK (Technological Pedagogical Content Knowledge; Koehler & Mishra, 2006) conceptual framework model is a valuable starting point in understanding and observing teaching practices that take into account the dynamic relationships that exist between technology, pedagogy, and content. The framework emphasizes the critical interplay between these three domains while recognizing the influence that "individual teachers, grade-level, school-specific factors, demographics, culture and other factors" have on effective technology integration (Koehler, 2012).

Bauer (2012) investigated this concept within music education and found that music teachers often lack a clear understanding of how to extensively apply technology into their teaching. Though many indicated that they had strong content and pedagogical knowledge, their technological knowledge was substantially lower. Therefore, continuing to develop teachers' awareness of technological strategies that align with their curricular goals is essential to ensuring students can effectively utilize digital learning resources. Several studies in both general and music education have indicated that there is a much greater need for professional development opportunities that assist teachers in learning

about and practicing with technology within their respective teaching contexts (Corn & Stanhope, 2014; Kopcha, 2008; Tucker, 2016).

There is an increasing amount of research that explores the benefits of technology use in school music programs, as well as the challenges and limitations it may present. Several music technology advocates argue that digital music culture is one that emphasizes greater inclusivity, collaboration, and interaction (Beck-Hill & Rosen, 2012; Burnard, 2011; Cayari, 2015; Davis, Greenwood, & Wise, 2011; Partti, 2014). The wide range of music technology applications available for students today provides extensive opportunities for them to engage in digital music creation, collaboration, and performance (Greher, 2004; Savage, 2005; Ward, 2008). Within music education, researchers have extensively examined student activities in the context of technology-based music courses, which have become an increasingly popular option for non-traditional music students (i.e., students not involved in performance ensembles) to engage in music-making in schools (Dammers 2012; Williams, 2011). Students expressed their appreciation for the autonomous nature of these classes providing them with the freedom explore musical creative processes.

The connections between digital music practice and musical creativity have also become a greater area of interest over the past several years (Burnard, 2007; Leman & Nijs; Partti, 2014). Use of various technologies has cultivated informal learning practices and environments in which students are free to explore multiple avenues for creating music. Partti (2014) found that digital musicians often have a great deal more flexibility in the type of work they produce compared to classically-oriented musicians, being that

much of their creative output involves creating and combining a multitude of new and original sounds. Digital music-making heavily encourages this type of innovation and experimentation with sound production, and it sets little limitation on what one may deem musically acceptable in traditional Western music practice.

Music software applications can engage students in skills that extend into many facets of musicianship. Several studies have indicated these applications can help promote learner-centered environments, which improves student engagement by fostering collaboration and individualized learning (Bassett, Franey, Horsley, McKnight, O'Malley, & Ruzic, 2016; Lum, 2017; Williams, 2017). Davis, Greenwood, and Wise (2011) emphasized technology's role in facilitating music educators' abilities to introduce a wide array of musical styles and topics. However, many music teachers continue to not fully utilize this wealth of resources and have been shown to primarily use technology for administrative purposes (Dorfman, 2008; Dorfman, 2016).

Much of the research in music education technology applications has focused on composition-based activities (Cremata & Powell, 2017; Greher, 2004; Savage, 2005; Ward, 2009). Ward (2009) found that students appreciated learning in a hands-on environment that gave them the flexibility to freely experiment with sound and musical structure. Having students work outside of traditional compositional rules within digital platforms allowed them to transform sounds into products that were truly unique and original. Access to social communities online has also widely broadened creative opportunities for students. Cremata and Powell (2017) introduced online collaboration activities as a method to "deterritorialize" education. In their study, students engaged in

music composition through online collaborations. The findings revealed that not only did the students' roles shift to become more collaborative, but the teacher's role became more facilitatory rather than directive. Similar studies of music composition and technology have connected music compositional processes to film (Cayari, 2015; Greher, 2004). Students were required to score a piece of film with music they created, which resulted in higher levels of engagement and deeper understandings of musical compositional processes.

The seemingly endless amount of technology applications available now has afforded teachers the opportunity to expand the types of activities they utilize in the classroom. It should be noted that much of the previous research on music education technology has relied on schools having access to extensive digital resources outside of music classrooms, such as music technology labs. However, with recent developments in educational technology, such as the initiation of one-to-one programs (one laptop, tablet, or other mobile computing device per student), there are many new curricular possibilities that provide a greater level access to digital resources within any classroom environment.

Problem Statement

A particular technology initiative that is gaining momentum in educational institutions is the implementation of one-to-one computing programs. These programs are rapidly becoming an essential component of many teaching environments, widely extending the potential of utilizing digital methods and strategies within teaching and learning (Beck-Hill and Rosen, 2012; Cotten, Farkas, Niiya, Warschuauer, and Zheng,

2014; Larwin & Williams, 2016). Much of the research in general education studies has suggested that one-to-one computing models lead to positive educational outcomes (Delgado, McKnight, O'Malley & Wardlow, 2015). Integration of these programs into classrooms has given teachers the ability to differentiate and individualize instruction more effectively (Beck-Hill and Rosen, 2012). In addition, giving all students access to digital devices both at home and at school has improved educational equity (Farkas, Niiya, Warschuauer, and Zheng, 2014).

Although a multitude of one-to-one computing studies have been conducted in general education research, there is still a significant lack of research within the field of music education (Dorfman, 2016). While there are an immense amount of technological applications and tools currently available for music listening, creation, and performance, there is little understanding to how these are being used in music programs and to what extent music teachers are incorporating one-to-one in their teaching.

Purpose Statement and Research Questions

The purpose of this study was to identify applications and teaching strategies utilizing one-to-one technology in one exemplary middle school music setting. The questions explored included:

- How does the teacher apply one-to-one technology in his program?
- How has one-to-one technology improved his teaching approaches?
- How does one-to-one technology support his educational philosophy?
- What factors support or inhibit his use of one-to-one technology?

- How does the role of one-to-one technology in the teacher's instruction relate to the Concerns-Based Adoption Model?

Definitions

Educational technology: "The study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" (The Association for Educational Communications and Technology, n.d.)

One-to-one computing models: "Programs that provide all students in a school, district, or state with their own laptop, netbook, tablet computer, or other mobile-computing device. *One-to-one* refers to one computer for every student" ("One-to-one", n.d.).

TBMC (Technology-Based Music Classes): Courses in which "technology is the primary medium for music instruction," often "designed specifically to reach non-traditional music students" (Dammers, 2012, p. 73).

TPACK (Technological Pedagogical Content Knowledge): The interplay between "Content (CK), Pedagogy (PK) and Technology (TK)" and the "knowledge that lie at the intersections between three primary forms: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK)" (Koehler, 2012).

Delimitations

The current case study will be limited to a middle school program with sufficient access to technological resources using one-to-one computing programs. Several contextual factors have a significant impact on one-to-one integration (demographics, administration, parental involvement, communication, funding, etc.), so the results are not generalizable to all music classroom settings.

Chapter 2: Literature Review

Teachers can employ a multitude of strategies to ensure that technology integration results in effective student learning. Given the rapidly accelerating pace of digital tools, there is a persistent need to continually identify and understand educators' instructional methods when using technological applications in the classroom. The following review of related literature examines studies pertaining to Technological and Pedagogical Content Knowledge (TPACK) as a conceptual framework, digital musicianship and its connections to technology-based music classes, technology applications utilized in a variety of music classroom settings, and implications and potentialities of one-to-one computing programs in both general and music education.

Technological Pedagogical Content Knowledge (TPACK)

In order to employ digital methods of teaching most effectively, it is essential that teachers continually strive to integrate technology that complements their pedagogical practices, rather than viewing it as an entirely disparate component to their curriculum. Bauer (2012) conducted a study utilizing the conceptual framework TPACK (Technological Pedagogical Content Knowledge), a hybrid educational model that closely examines the relationships that exist between technology and pedagogy (Koehler & Mishra, 2006). The purpose of the framework is to provide educators and researchers with an understanding of how digital methods of teaching and learning should jointly intersect with curricular goals. Koehler and Mishra assert that TPACK is:

> The basis of good teaching with technology [that] requires an understanding of the representation of concepts using technologies; pedagogical techniques that

> use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (p. 1029)

The framework presents a model by which the emphasis becomes not on the technology itself, but on the "connections, interactions, affordances, and constraints between content, pedagogy, and technology" (Koehler & Mishra, p. 1025).

Bauer (2012) noted that music educators are often not aware of how to extensively use technology for instruction. For the study, the researcher aimed to develop and administer an instrument to measure music educators' TPACK, determine how they acquire their TPACK, and discover if a relationship exists between music teachers' TPACK and their reported integration of technology.

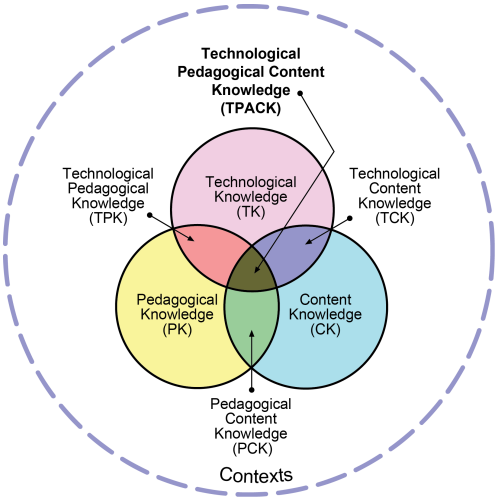

Figure 1. Technological Pedagogical Content Knowledge (2012). Reproduced by permission of the publisher. Retrieved from http://tpack.org

For the initial portion of the study, 284 music educators from 26 states enrolled in one-week music technology workshops located throughout the United States. The participants primarily worked in public schools (89%), the majority of which were located in suburban areas (59%). Most of the teachers were either band (43%) or choral (41%) directors, but nearly all music areas and grade levels were represented in the study. Bauer (2012) initially designed and issued a Musical TPACK Questionnaire (MTPACK-Q) to participants which measured the various components that comprise their TPACK and how they developed their understandings of the TPACK domains (i.e., content knowledge, pedagogical knowledge, technology knowledge, technological content knowledge, technological pedagogical knowledge, etc.). In addition, using the Concerns-Based Adoption Model-Levels of Use (CBAM-LoU; Christensen & Griffin, 1999), the researcher had teachers self-assess their uses of technology within their instruction.

The findings demonstrated that teachers ranked themselves highest in pedagogical knowledge (86%) and content knowledge (85%), whereas technological knowledge ranked the lowest (71%). Respondents indicated that they primarily learned about technology on their own (60%), through summer workshops (56%), and by attending music education conferences and conventions (59%). Approaches for teaching with technology were generally acquired through self-exploration (65%) as well as through school district in-services and from friends and mentors. Only a third of respondents specified that they acquired their TPACK during preservice training. The results revealed that respondents with higher MTPACK-Q scores also noted higher levels of technology use in the surveys. The researcher found a moderate, positive, significant ($r = .51$, $p \leq .$

01) correlation between participants' MTPACK-Q score and reported levels of technology use.

Due to the fact that the teachers in this study elected to participate in workshops to familiarize themselves with music technology and were not randomly selected from a larger representative population of teachers, the data may not be generalizable to all music educators. The TPACK model can continue to assist educators in recognizing the necessity of building technological competencies to best meet the needs of contemporary learners (Bauer, 2012). Carefully considering how to develop fluid relationships between content, technology, and pedagogy will help enhance classroom experiences and provide students with essential 21st century skills.

In a later study, Bauer and Dammers (2016) examined TPACK for preservice music teachers and how it was being addressed within their music education programs. The researchers aimed to determine whether these programs prepared teachers to utilize digital technology within K-12 music classroom settings. They explored the music technology course requirements within the programs, the degree to which TPACK was addressed and developed, and the specific challenges preservice teachers faced in integrating technology.

Eighty-nine music education professors responded to a national survey that was designed to measure the "role, nature, and efficacy of technology instruction in their program" (Bauer & Dammers, 2016, p. 2). Professors from 34 states participated in the study, and their programs had a mean of 90 preservice music education students. Using a quantitative, descriptive research design, the survey measured the extent to which the

programs' curricula developed students' technological knowledge (TK), such as communication through digital technology, use of mobile computing devices, and capturing audio/video/graphics using multimedia. Questions also addressed the types of technology-related classes students were required to take and if these courses explored instructional design practices utilizing technology.

The results revealed that 47% of the programs had a music technology course requirement for all music majors, and 33% percent had a technology course specifically designed for music education majors. Seventy-seven percent of respondents indicated that the preservice teachers' music education classes provided students with opportunities to learn about pedagogical strategies applying technology. Based on a 5-point Likert-type scale (1 = "Never" to 5 = "Always"), the results revealed that students developed TPACK through field observations (M = 2.98; SD = 1.12), peer teaching experiences (M = 3.30; SD = .95), and by developing technology-integrated lesson plans through their courses and field experiences (M = 3.45; SD = .93). Similar to the previous study, the measurements of the students' TPACK domains ranked highest in pedagogical knowledge (81%) and content knowledge (74%), whereas their technological pedagogical and content knowledge remained low (54%). Based on another 5-point Likert-type scale (0 = "Not prepared at all" to 4 = "Advanced level of preparedness"), professors generally believed that their students had a proficient level of preparedness in integrating current (M = 3.24; SD = .88) and future (M = 2.99; SD = .92). technologies into music instruction. Lastly, the findings demonstrated that the challenges students faced with technology usage included lack of instructional time, funding, and access. Overall, the

study's results suggested that there remains a need to provide preservice teachers a greater amount of opportunity to learn about and utilize current technologies as they develop instructional methods throughout their preservice music education programs.

Researchers within both music and general education have continued to adopt the TPACK model in emphasizing instructional processes that introduce technological strategies through a pedagogical lens. Divaharan and Koh (2011) examined TPACK development in preservice teachers by proposing and utilizing the TPACK-Developing Instructional Model, which outlined three specific phases of TPACK development: "fostering teachers' acceptance and technical proficiency; pedagogical modeling; and pedagogical application" (p. 35). The researchers designed an instructional intervention involving 74 preservice teachers who pilot-tested an Interactive Whiteboard system. Eighty-five percent of the participants were female, primarily under the age of 25 (65%). A pre-survey study determined that 90% of respondents had not previously utilized the Interactive Whiteboard.

For Phase 1 of the study, "fostering acceptance," the preservice teachers were paired with a faculty tutor who assisted in organizing pedagogical strategies, such as outlining weekly presentations, utilizing the Interactive Whiteboard. For Phase 2, "technological and pedagogical modeling," the tutor introduced basic features of the Interactive Whiteboard and explored functions of the complementary software. Participants also searched through a database of subject-specific lessons that used the Whiteboard system. For the final phase, "pedagogical application," the preservice teacher

participants worked together in groups of three or four to create three examples of Interactive Whiteboard lesson activities.

Divaharan and Koh (2011) collected qualitative data through an end-of-class reflection forum that asked students to discuss how they thought they could potentially use the Interactive Whiteboard in their future classrooms and to describe their experiences learning about the Whiteboard individually and with team members. The TPACK constructs that emerged from the responses were predominantly Technology Knowledge (TK) and Technological Pedagogical Knowledge (TPK). Many of the reflection comments in Phase 1 related to TPK (33%), which revealed that faculty modeling helped preservice teachers devise pedagogical strategies utilizing the technology. These included methods such as projecting multimedia to help stimulate students' interest in the material being presented and using the board's annotation feature to write notes which could be distributed to the class after the lesson. Several comments pertained to TK (58%), for which students indicated an appreciation for the touch-sensitive screen and capability to use multimedia presentation software.

Teachers' TPK reflection comments increased in Phase 2 of the study to 52%, and included ideas of using the Interactive Whiteboard for quiz games and to stimulate active learning through the board's drag-and-drop features. Comments in Phase 3 of the study were also predominately TPK-related (55%), encompassing ideas such as using the board for classroom management, with consideration given to elements of the presentation material such as font-size and colors. Respondents' TK comments related to uses of the accompanying Notebook software. Based on the findings of the study, Divaharan and

Koh (2011) concluded that the TPACK-Developing Instructional model was effective in developing preservice teachers' confidence in using technological tools in their instructional practices.

Overall, the Technological Pedagogical Content Knowledge (TPACK) framework is a valuable model in understanding the integral relationships that exist between technology, teaching, and learning. Bauer and Dammers (2016) and Divaharan and Koh (2011) point to the vital need to address TPACK in preservice teacher education programs in order to ensure that new teachers feel comfortable integrating effective digital learning practices into their curriculum. University education professors should aim to provide students ample opportunity to observe effective technology implementation within live teaching contexts and teach about lesson plan development methods that blend content, pedagogical, and technological knowledge. Studies by Bauer (2012) and Bauer and Dammers (2016) demonstrate that opportunities to explore technological knowledge (TK) is still lacking particularly within music education preservice teacher programs and that many music teachers rely on self-exploration to learn about technological trends. While this may be necessary given the fast pace of technological advancement, addressing TPACK as a conceptual framework in preservice training will help teachers continually think about digital integration in a way that best complements their curricular objectives and goals.

Educational Technology

General education research on technology integration and effectiveness has proliferated over the past few decades. Delgado, McKnight, O'Malley, and Wardlow

(2015) conducted a thorough literature review spanning from 1984 to 2014 which focused on educational technology use within classrooms and online educational environments. The researchers' primary questions were: "(1) How is technology currently being implemented in schools? (2) What investments have been made to support educational technology? How do investments increase technology use and integration in schools? (3) How effective is educational technology?" (p. 399).

Regarding technology implementation, recent findings have indicated that there is an expanding movement to increase access to digital learning resources through implementation of one-to-one computing models. These programs have allowed teachers to find more efficient means to improve student learning and employ a wide array of new instructional strategies. Delgado et al. (2015) found that much of the research demonstrated that students in one-to-one programs exhibited increased engagement as well as improved research and collaboration skills (p. 409). Implications of these vastly expanding programs will be addressed later in this chapter.

Expenditures in K-12 e-learning continue to increase in the United States, accounting for 0.7% of the $718 billion education budget in 2013, and Internet access has increased to 93% within classrooms (Delgado et al., 2015, p. 405). Even with these substantial increases in access, teachers' use of technology still remains relatively low, with only 40% of educators indicating that students use computers "often" during instructional time. Researchers have found that teachers' use of technology is often limited to administrative purposes, such as attendance, grading, and planning. Results on the effectiveness of technology implementation, particularly over long periods of time,

remain somewhat mixed. There is a continued need for methodologically sound studies that explore both the positive and negative aspects of digital initiatives in schools. Delgado et al. (2015) identified several transformative benefits that technological tools provide within educational contexts, such as "more opportunities for 1 to 1 interactions with teachers…flexible learning environments…[reduced] scheduling conflicts…and [decreased] dropout for at-risk students" (p. 410). With the persistent push to increase funding for technology resources in school districts, researchers must conduct ongoing investigations on technology's integration into instructional design and practice.

Bassett, Franey, Horsley, McKnight, O'Malley, and Ruzic (2016) aimed to determine how to best use technology to strengthen student learning and the roles that technology plays to enhance pedagogical practices. The researchers used a mixed-methods, multisite case-study design. There were seven school sites that participated in the study, located within different regions of the United States in both rural and urban settings. All schools had implemented a wide range of technology initiatives and were selected based on their commitment to successfully integrate technology into the curriculum.

Bassett et al. (2016) collected qualitative data through focus groups and interviews with teachers and administrators, as well as through classroom observations. The teachers participating in the study were initially required to complete an online survey designed to measure their familiarity with technology. The majority of teachers in the study indicated that they felt comfortable with technology (> 90%) and had taken part in professional development opportunities to expand their technological skillset.

However, their proficiencies were generally limited to common technologies rather than applications that were field-specific.

The study demonstrated that contextual factors play a significant role in the overall success of technology implementation, such as demographics, administration, parental involvement, communication, funding, support, and a multitude of other factors. These variables are highly important to take into account when examining the uses of technology in schools. Some of the sites emphasized developing a strong pedagogical model before integrating technology while others tied instruction directly into technology (e.g., flipped model). For many of the schools, Basset et al. (2016) determined that technology was utilized as a means to improve access for students with special needs and disabilities, providing teachers the capability to differentiate and individualize instruction for all types of learners. In addition, technology was frequently used to strengthen collaborative work and build social interaction amongst students.

The researchers found that technology lessened the amount of time that teachers previously had to spend on administrative tasks, such as grading and tracking student improvement, which enabled them to provide students with greater one-on-one support and immediate feedback. Also, rather than spending most of the class time on teacher-directed instruction, students engaged in independent research which provided them more of an active role in the learning process. Some teachers would have students share their work online for the teacher and peers to review, giving them a greater sense of accountability in producing work of high quality. Through these techniques, the teachers' roles shifted from a direct instructional model to one that was more facilitative. In order

to adopt this model effectively, many pointed to the crucial role of leadership and community-wide support.

Throughout the study, researchers found that teachers desired ongoing professional development opportunities in using specific technologies, and they preferred this to be teacher-driven rather than organized by the school district. Within schools, Basset et al. (2016) suggested teachers should be encouraged to collaborate with colleagues and share ideas and resources to help augment student learning through technology. They determined that communication and collaboration between teachers and administrators is essential, and context always plays a key role in the successful implementation of technological learning aids. Schools may discover particular instructional methods that work well in one school setting may not necessarily suit their students' needs. Though the study outlined several critical digital learning strategies, pedagogical integration is clearly dependent on particular aspects of the school setting. This study was limited to schools that had ample resources and positive community support for technology. As this is certainly not the case in all schools, it is crucial to continue examining experiences with technology in a variety of classroom settings.

These studies conducted by Basset et al. (2016) and Delgado et al. (2015) conclude that teachers uses of technology in classrooms continues to be somewhat limited, despite the largely expanded allocation of funds toward educational technology initiatives. Technology has given teachers the ability to widely broaden and enhance their instructional capabilities, though both studies emphasized the strong influence of contextual factors on successful implementation of technology. As digital devices

continue to revolutionize the ways in which society operates, teachers have regularly expressed ongoing desire for more training and professional development opportunities to learn about how they can utilize these tools effectively.

Technology-Based Music Classes and Digital Musicianship

Digital music culture is quickly becoming increasingly prevalent within the music industry and it is critical to recognize the implications this has for music education, whether it be in general music or ensemble settings. Over the past several years, technology-based music classes (TBMCs) have become a popular curricular offering in schools, and a substantial amount of research has been conducted regarding digital learning strategies within these types of classes. For the current study, the pedagogical techniques employed in these courses can assist the researcher in better understanding technology applications within the context of both secondary ensembles and general music classes.

Dammers (2012) investigated the extent to which TBMCs were offered in schools throughout the United States as well as the curricular nature of these courses. For the first part of the study, the researcher administered a survey to administrators in 10% (N = 1830) of comprehensive public high schools in each state, which aimed to determine the number of schools that offered TBMCs and if factors such as socioeconomic status and geographic location had an impact on their availability. For the second part of the study, Dammers issued a survey to TBMC teachers from the schools identified in part one and asked them about particular aspects of their curricula, such as what types of hardware and

software they utilized in their classes. In addition, the researcher sought to gain an understanding of the level of support provided by the district for TBMCs.

From the 528 responses to the administrator survey (a response rate of 29%), the findings indicated that 14% of the schools offered technology-based music classes. Of the principals who responded, 66% viewed TBMCs as a positive offering. The findings revealed that the schools most likely to offer technology-based music classes were suburban high schools located in the Northeast, whereas rural schools in the South and West were least likely to offer these courses. In regard to socioeconomic status, no statistically significant difference was found between categories $\chi 2$ (4, n = 504) = 8.492, p = .075). This may have been due to the fact that fewer schools of low socioeconomic status responded to the survey.

For the second part of the study, Dammers (2012) used a 4-point Likert-type scale in which teachers rated the importance of various objectives in their curriculum (3 = "Very Important" to 0 = "Not Important"). The role of standard music notation seemed relatively limited in most TBMCs, with a mean response of 1.72. The objectives of creating, listening, and vocational skills, such as recording, were all viewed as important (M > 1.5). Regarding the types of musical styles addressed in TBMCs, the data showed that rock music had the highest ranking (M = 2.2), followed by classical and jazz. Folk music, hip hop, and rap were generally viewed as less important. A variety of music hardware and software programs were used in the teachers' courses, such as GarageBand (73%), microphones (73%), Sibelius (64%), mixing boards (50%), Audacity (41%), and digital pianos (36%). The findings revealed that districts were generally supportive for

hardware and software installation and service. However, there was a low level of support for in-service training, so respondents primarily relied on self-study, external in-services, and music conferences for expanding their technology knowledge and skills.

In an earlier study, Dammers (2010) evaluated the processes and motivations of initiating TBMCs by conducting a case study in a large, suburban New Jersey high school. The school was comprised of mostly white and middle class students and had a moderate level of enrollment in its music program (13% of the school population). The researcher utilized semi-structured interviews for the study and coded data "by the categories of background information, motivations, and conditions" (p. 57). The idea of the TBMC was proposed by the band director, who believed the class could help expand enrollment in the school's music program. The district was highly supportive of curricular innovation, so the director worked closely with the assistant superintendent to obtain funding for the class.

In the interviews, Dammers (2010) discovered that the assistant superintendent emphasized the need for expanding student opportunities to participate in the arts, and the band director hoped the course would strengthen the music department and boost enrollment and staffing. With minimal recruitment, 53 students enrolled in three sections of music technology in the first year. In addition to a very motivated and supportive administration, budget, staff, and space were all crucial components to the success of the music technology course. Findings from the study signify the importance of broadening the reach of music education to non-traditional music students. Effective technology

integration into traditional instrumental settings may also yield a higher level of student engagement.

Music technology courses can often provide greater access and opportunity for all students to meaningfully participate in music-making. Williams (2011) assessed the general attributes of students who participated in TBMCs. By analyzing data from many previous studies (Edwards, 2006; Elpus and Abril, 2011; Johnston et al., 1976-2009; Stewart, 1991), the researcher found that approximately 80% of all students in the United States were not involved in ensembles within a school setting, and this has remained relatively consistent going as far back as 1986 (Williams, 2011, p. 135). Also important to note, the researcher found that there is a significant increase in non-participation in music and the performing arts between eight and tenth grade ($\chi 2 = 0.001$) and eighth and twelfth grade ($\chi 2 = 0.0004$).

To explore the typical characteristics of TBMCs, a survey was completed by 14 teachers of these courses in secondary schools. The data revealed that many of the students enrolled did not participate in traditional performing ensembles (82%), though some were involved in musical activities outside of school such as rock bands, church groups, or music lessons. Many of the students sang or played an instrument (67%) but often did not read music notation (78%). Participant responses also demonstrated that many TBMCs included special-needs students or students who had disciplinary challenges in school. Teachers reported that the autonomous and hands-on nature of these classes helped students find motivation and success. On the other hand, traditional

ensembles sometimes do not provide the type of environment in which these students are socially accepted and can freely explore their musical creativity.

With increasing opportunities for students to engage with music technology in school music programs, research has begun to examine the concept of digital musicianship and how it has the potential to widely expand students' musical experiences and creative potentials. Partti (2014) aimed to explore the values of musicianship within the realm of digital technologies and how this may change our perceptions and practices in the field of music education in general. The researcher asserted that "values emphasizing aspects of musical versatility and flexibility, as well as mobility between various musical communities of practice, are specifically connected with digital musicianship" (p. 3). Partti suggested that encouragement of musical versatility is essential to 21st-century educational practices as musicians become increasingly interconnected and new technologies transform music learning, creation, listening, and collaboration. A key characteristic of digital musicians is that they are often involved throughout the entire musical process, from creation and production to performance. In contrast, traditional musicians often primarily focus on the performance aspect of music-making.

Parrti (2014) conducted a qualitative instrumental case study examining the perspectives and experiences of several digital musicians within a London-based music college. She sought to identify what these musicians found particularly valuable and meaningful in music-making, participation, and learning. Through a series of video observations and interviews, the researcher collected data that helped her gain a sense of

the musicians' everyday lives as well as their experiences, opinions, and understandings of music study and creation. The interviews were semi-structured and focused primarily on participants' personal narratives. In analyzing the data, the researcher identified emerging themes in digital musicians' narratives and reflected on how their stories might expand into views and attitudes of musicianship in general.

The students' college music program emphasized a broad level of competence in music technologies, regardless of their musical tastes and preferences. None of the participants entered the program with formal training, and most of their musical understandings were shaped through digital devices. Computers assisted in developing their musical identities and creative processes, and many students were captivated by the idea that creation through digital devices often produces unexpected results. Also, given the nature of digital music, there were not clear dividing factors between composing, arranging, performing, and engineering. Musicians were required to be active in all parts of the music-making process.

One of the participant's stories demonstrated how digital musicians are usually involved in multiple communities of practice, in contrast to classical musicians who usually fall into a particular area of specialization. Digital musicians must constantly adapt and innovate to meet the needs of the communities in which they are involved. As educators, we must now continually redefine the notion of musicianship and avoid compartmentalizing our ideas about how music should be made. As the study revealed, creativity can emerge in a variety of ways, and students' engagement with digital music-making must be taken into account.

Transforming music education to be all-inclusive requires that schools provide course options that attract non-traditional music students (Dammers, 2010; Dammers, 2012; Williams, 2011). Educators must try to ensure that all students, regardless of background, have opportunities to participate in music within school settings. These studies show that music technology enables students of all abilities to utilize innovative tools that make the process of music making more accessible. Student opportunities within music education should not be exclusively available to only a small minority of students. The dynamism of musical culture today is largely due to the pervasiveness of technology in society, and educators should embrace its abilities to accommodate every students' inherent musical capacities (Partti, 2014). The notion of musicianship must encompass broader populations of musicians, extending from traditional to contemporary.

Music Education Technology: Applications and Instructional Strategies

There is an ever-increasing wealth of technological resources to help students engage in a wide range of musical activities in the classroom, such as composing, performing, recording, collaborating, and listening. By utilizing digital applications, students have the ability to gain broad musical understandings and participate in music-making regardless of age or skill level. Over the past several years, music education policymakers have responded to the need for technology integration in schools by introducing standards to expand and improve upon digital methods of teaching and learning. By including these standards in the curriculum, music teachers should begin to fully recognize how technology can broadly enhance instructional practices. A study by Crawford and Southcott (2011) utilized qualitative document analysis to identify and

analyze curricular statements "concerning music and concerning information and communication technology in Australian state and territory education guidelines" (p. 125). Based on the documents, the researchers discovered five recurring themes regarding the roles of technology in education: "(1) communication (local and global), (2) critical thinking, creativity and problem solving, (3) research, (4) societal context, and (5) tool/skill" (p. 126).

Based on several of the Australian music education technology standards, the role of communication technology was identified as a means to contribute artistic products to broad audiences online and to collaborate with other musicians in both local and global contexts through virtual communities (Crawford & Southcott, 2011, p. 128). In addition, the standards addressed technology's use as a tool to expand student inquiry, musicality, and self-expression. The researchers expounded upon additional standards that emphasized technology's capabilities to place music within broad societal contexts and show music's values between various cultures. The standards also place importance on students' abilities to "become independent, lifelong learners" who are actively engaged within local and global communities (p. 127). Lastly, the technology standards in music education indicate that digital learning should promote the aims of interdisciplinary study. By taking all of these standards into consideration, music educators can devise classroom activities that address a broad range of musical concepts and skills through digital learning resources.

In order to gain a better sense of specific digital teaching strategies within music education, Davis, Greenwood, and Wise (2011) examined the perceptions and practices

of secondary school music teachers with regard to technology and how it affects their work. Nine teachers from New Zealand participated in the study, each of whom taught at secondary schools with successful music departments and highly supportive technology environments. The researchers utilized four schools for the study that represented a mix of co-educational and single-gender schools as well as high and low socioeconomic statuses.

Davis et al. (2011) used a mixed-method approach for the study, issuing questionnaires, conducting semi-structured interviews, and observing teachers to gain insight on how they utilized digital technologies both at home and at school. The primary source of the data was a 30-minute interview that focused on why the teachers used particular software programs and how it influenced their pedagogical approaches. The data were categorized into various themes, which included the shift from instructivist to constructivist philosophies, teacher-centered to student-centered learning activities, and use of local resources to multimodal information.

The findings revealed the majority of the participants used programs such as Sibelius and GarageBand in their music classes. Using these programs, some teachers, for example, specified that they would have students compose melodies based on certain rhythms or chord progressions. Davis et al. (2011) indicated that teachers found it particularly useful that these software programs provided students with instantaneous feedback, so when working in programs like GarageBand, students who may have been less familiar with music could still successfully create songs.

However, in a few of the interviews, teachers' indicated that they were somewhat skeptical of using these types of software programs, because students were using simplistic processes to create their music, such as copying and pasting, or dragging and dropping loops. They did not demonstrate an authentic understanding of musical concepts and relied primarily on experimentation. Therefore, Davis et al. (2011) found that most of the teachers stressed the importance of a sequential learning process in using this software by first introducing Western music theoretical concepts and notation traditionally, then devising activities that incorporate the use of these programs.

Other supplemental technologies participants utilized were YouTube, podcasts, and other relevant online resources that would help demonstrate music-related skills. The teachers felt that all these technological resources assisted in a higher level of student engagement and achievement. Generally speaking, the interviews and questionnaires indicated that technology was an essential component to the teachers' music courses, but use of these tools should still be blended with practices that provide students with traditional experiences, such as developing skills on an instrument (Davis et al., 2011).

Looking further into specific applications of technology in the music classroom, Dorfman (2008) examined multiple areas of technology integration within K-12 music programs throughout Ohio. The study investigated the types of technology used by teachers, teachers' level of comfort with technology, teacher training in pedagogical application, and obstacles in implementing technology in the classroom. The researcher stressed that there are multiple variables that determine how successfully technology can be fused into music teaching, such as school setting, administrative support, teacher

attitude, and several others. Teacher training programs, standards, parental support, and other external factors also play a significant role in how technology is used. The researcher not only considered how teachers use technology within lessons but also for planning and preparation.

In conducting the study, the researcher designed and administered a web-based survey to 1,477 music teachers of which 37% responded. Questions on the survey pertained to respondents' teaching backgrounds, training, school environments, comfort levels with technology, frequency at which they use technology, and barriers to technology integration. Participants were also asked to identify what types of professional development might be most helpful to them in further incorporating technology in the future. Most of the respondents to the survey were band directors, though all areas of music teaching were represented in the results.

Dorfman (2008) found the most common technology uses were burning CDs (21%), writing or arranging music with notation software (18%), and electronic accompaniment (12%). It should be noted that the music technology landscape has drastically changed over the past decade, so certain aspects of these results may not be fully pertinent for music teachers today (i.e., CD burning). The data also revealed that personal technology use for preparation purposes tended to be higher than student technology use in the classroom. With regard to comfort levels using technology, the researcher utilized a six-point Likert-type scale (1 = "Not comfortable at all" to 6 = "Extremely comfortable") for teachers to rate their personal technology expertise. Participants' data showed a mean score of 3.29 (SD = 1.392) regarding use of technology

for musical tasks and 4.90 (*SD* = 0.887) for non-musical tasks. The Pearson Product Moment statistic indicated a "moderate positive correlation between comfort with general technology and comfort with music technology ($r = .49$, $p < .01$)" (Dorfman, 2008, p. 31). Many of the respondents reported that most of their knowledge of technology resulted from personal exploration (83%) rather than formal training. The results demonstrate that even if teachers feel comfortable using technology for personal consumption, they are often unaware of how to effectively apply it pedagogically. This indicates that there is a greater need for professional development opportunities for both current and future teachers.

Looking further into the potentials of digital music strategies in the classroom, Ward (2009) designed and implemented composition-based activities that utilized a wide range of Information and Communication Technology (ICT) approaches within his middle and secondary school classrooms. The researcher examined how ICT could be utilized to encourage musical inventiveness through non-fixed-tonal environments. Through the activities, he also attempted to gain an understanding of how informal learning may increase student motivation and engagement throughout the creative process.

The researcher used qualitative and action research methods to conduct the study with his own music classes. Participants were 189 students ranging from age 11 to 16 in class sizes varying from 14 to 31 pupils. Each of the classes was given a different ICT-based compositional activity that involved various software programs. They were provided with pre-research questionnaires in which the researcher asked for students'

input in the design of the activities before the project began. Over the course of the study, data were collected through feedback questionnaires, pupil evaluations, video interviews, recordings of classes, student work files, and informal monitoring.

The first two stages of the project were implemented during one semester and involved the students working their way through music composition assignments. The third stage was an evaluative stage in which the researcher analyzed the feedback and observations gathered from the previous stages, which led to further refinement of the activities for the fourth stage. This final stage involved only one class and drew from information gathered from previous stages to simply clarify and refine the projects.

In organizing the findings, Ward (2009) divided observations into five categories that helped to define the primary uses of digital technologies: developing ideas, making connections, making meanings, constructing shared knowledge, and communication and evaluation. Students found the exploratory nature of the learning environment to be enjoyable and appreciated the hands-on and open-ended structure in developing their creative ideas. They felt like they established connections to others through a peer-supported atmosphere that allowed them to freely explore their imaginations. Interestingly, many noted that they found more meaning in the non-fixed-tonal creations compared to tonal styles because they were able to synthesize a product that sounded completely original. Throughout the project, the video interviews and questionnaires were beneficial in helping students evaluate their work and develop and reflect upon their goals.

In a similar study, Savage (2005) explored compositional activities for students aged between 11 and 16 in rural high schools in Suffolk, England. The researcher aimed to understand the impact of ICT on students' learning processes in music, particularly for composition, and how the incorporation of technology affected teachers' pedagogical strategies. Using case study and action research methods, the researcher designed activities for three classes in which students experimented with sound processing technologies and explored digital composition tools. One of the projects required students to compose music and create films based on sounds and imagery of their community. Another project involved students synthesizing music inspired by their village's history. Savage collected data through observation notes, interviews, pupil diaries, and a concluding questionnaire.

Through the various activities and projects, the researcher discovered that students appreciated the freedom and flexibility the compositional activities afforded them. Rather than emphasizing composition processes that were "right or wrong," students preferred working in the "pedagogical framework of exploration and discovery" (Savage, 2005, p. 171). Technology allowed students to quickly generate new ideas by manipulating and transforming sounds, which provided them limitless creative possibilities. The selection of different sounds was a vital part to students' compositional methods, and given the experimental nature of the project, students found this enjoyable and fairly straightforward.

However, the researcher discovered that students would often focus too heavily on compositional structure in the early stages of the project. He pointed to the importance

of emphasizing "diversity and variability of outcomes," but students "often found it difficult to improvise freely without…structuring [their] ideas within a…permanent compositional framework" (Savage, 2005, p. 177). With the use of ICT in music education, the researcher argued teachers and students must recognize the wide variability of compositional processes and place less of focus on the end product.

Another activity observed by Cremata and Powell (2017) involved students completing an online music collaboration project in which they were required to work with individuals outside of their classroom whom they had met through online music creation communities. The purpose of the study was to discover new pedagogical methods by which technology could be applied and help extend musical boundaries beyond the classroom. The researchers termed this "deterritorialized collaborations" (p. 302). Deterritorialization simply means that musicians "need not be located in the same physical space with another musician" to create music (p. 305). Throughout the course of the project, students were given the freedom to utilize a multitude of online musical applications to create songs that were three to five minutes in length. One hundred high school students from a variety of socioeconomic and racial backgrounds in Miami participated in the project. The students were not allowed to collaborate with others in their classroom over the course of the four-week project, but instead had to interact with another individual online who was not part of the school community. Few restrictions were given to the students, which allowed them to learn strategies of e-collaboration on their own and find the appropriate processes that best-suited their projects.

Prior to conducting the project, students received seven weeks of training on multiple digital music creation software programs and were given the freedom to use any of these tools in their collaborations. After the project was completed, the researchers held semi-structured interviews to gain a thorough understanding of students' perspectives and experiences with the activity. They aimed to evaluate students' viewpoints working with individuals whom they had met online, what they enjoyed, and what types of challenges they encountered both creatively and technically. Responses were organized using computer coding software.

The researchers found that students were generally quite enthusiastic about the project. With the level of freedom they were given, students felt empowered to take more control of their learning. Many enjoyed the e-collaboration process and finding ways to reach mutual solutions with their creative partners online. Over the course of the project, the teachers acted as a guide and facilitator rather than a strict decision-maker. This helped students develop an independent creative process and explore their musicality in unique ways that best suited their needs. Because of the degree of choice students had in the project, it had greater relevancy to their own lives and personal musical preferences. Cremata and Powell (2017) concluded that a "shift towards student-centered learning can foster musical agency and independent musicianship in democratic ways that might have potential for contexts within and beyond school" (p. 313).

Collaborative projects can encourage students to engage with their peers and help synthesize a participatory culture in which everyone in a learning environment feels wholly involved. There are a wide variety of activities that teachers can explore with their

students that allow them to explore musical creativity in both formal and informal ways. For instance, Cayari (2015) evaluated the effectiveness of an informal learning project with a group of 36 undergraduate music education students from a Midwestern university, in which students were required to create music videos in small groups over a period of four weeks. The researcher, who was also the teacher of the course, gave students flexibility in the style of music to be included in the video, and they were permitted to utilize methods of their choosing for both filming and editing the video. The primary focus of the study was to examine informal and autonomous learning processes utilizing technology. The teacher purposefully set relatively loose expectations for the project and took on a primarily facilitatory role throughout the process.

Cayari (2015) collected data by making observations about students' final products, issuing a web survey to gain a sense of students' general attitudes about the project, and conducting interviews to understand students' experiences more fully. Twenty students responded to the survey (56% response rate), and ten students elected to participate in an interview with an individual unknown to them. The observation data revealed that students synthesized a broad spectrum of music video styles, such as covers of pop and classical music, a variety of musical collaborations, and virtual ensemble arrangements. To edit the videos, 46% of respondents used iMovie, 25% used Windows Movie Maker, 17% used other software programs, while the remainder did not edit their video. By the end of the study, the results showed that 75% of participants became less intimidated in creating music videos over the course of the project.

Based on the researcher's open-ended survey and interviews, despite some initial anxiety, participants generally felt excited to share their work with their peers. It gave them "a sense of accomplishment and solidarity leading to a feeling of community that included encouragement and celebration of performance through video" (Cayari, 2015, p. 51). Although the project lacked the standard structure and guidelines students may have been accustomed to, they enjoyed having freedom to conduct the project in their own unique way. The online survey revealed 16 out of 18 respondents had a positive reaction to the video creation project. Seventy-five percent indicated feeling less intimidated about making music videos, and a few students even chose to publicly post their videos on YouTube at the completion of the project.

This study demonstrates that digital projects can provide teachers the flexibility to engage their students with informal learning practices. In their projects, students had a choice in what music they wanted to perform and how it was to be presented from both musical and visual perspectives. In addition, they often learned the music by imitating recordings without any specific guidance and were granted the opportunity to compose and improvise freely during the process, allowing them to explore music from a broader perspective apart from simply performing it.

Another music and video project-related study by Greher (2004) involved the design and implementation of a prototype software program called *Picture this! © 1997 : An Interactive Listening Environment for Middle School General Music*. The software provided students with active listening exercises in a variety of musical genres and had students add the music to film. The intention of the software was to "provide richer

educational experiences, engage adolescents in listening to a variety of musical styles and encourage group interaction" (p. 23). The researcher aimed to introduce aspects of cultural literacy by including examples of both popular and traditional styles of music in the software. Students utilized creative and critical thinking skills to decide on what music fit best within the context of the film, analyzing elements such as mood, rhythm, and melodic content. After completing each unit, students created their own music to accompany the film clips. Greher (2004) examined if use of the software helped encourage active participation, student-centered learning, and music-related problem-solving strategies. Three classes of sixth- and seventh-grade students from two inner city schools, both of which were comprised primarily of low-income Hispanic students, participated in the study. The researcher conducted classroom discussions and issued questionnaires to students and teachers in which they specified aspects of the software program that they either liked or disliked.

Overall, based on a Likert scale attitude survey (1 = "Strongly Disagree" to 5 = "Strongly Agree") students had positive impressions of the program and found it relatively easy to use ($M = 4.0$, $SD = 0.8$). They enjoyed being able to create music to go along with the films and engage in collaborative discussions about the musical scoring ($M = 4.5$, $SD = 0.6$). Although many of their initial attempts in music making did not match the action on screen, students exhibited increased intrinsic motivation throughout the project as they continually watched and reassessed how well their music worked within the context of the film. Teachers noted that the students took on a highly active role in their learning and engaged in stimulating discussions about their cultural

assumptions in regard to music and film. Greher (2004) asserted that music educators should take their students' interests and musical perspectives into consideration in order to help them develop a richer knowledge and appreciation of music. Computer applications now provide teachers with limitless opportunities to incorporate aspects of musical understanding that is relevant to their students' lives.

While there remains a considerable lack of research on music technology use in secondary ensemble classrooms, possibly due to the fact that there are fewer pedagogical technology tools geared specifically toward these classes, some music education software companies have begun to address the particular technological needs of educators and students within these settings. SmartMusic® is a web-based program with an extensive digital music library designed to be used for instrumental and choral ensemble instruction. The application has guided practice and assessment tools, built-in notation capabilities, sight-reading activities, and interactive accompaniment features (MakeMusic®, n.d.). With these available tools, the application gives teachers the opportunity to better individualize instruction for their students and keep them engaged with music practice.

Tucker (2016) conducted a multisite case study which evaluated middle school band directors' use of SmartMusic® in their daily teaching in order to determine successful instructional strategies and implementation barriers with the application for performance-based groups. Tucker (2016) claimed: "As more and more districts encourage educators to use technology in classrooms…the band classroom is not immune to this push in education; therefore, we find band directors searching for a tool to use in

their band rooms" (iv). Three band directors of varying ages and experience levels participated in the case study, each of whom taught fifth through eighth grade band. The teachers all had experience with SmartMusic®, which included training and professional development using the application.

During three scheduled classroom observations, the researcher took notes on how the program was utilized, student reactions to the technology, and classroom procedures. The findings revealed that participants utilized the program in both whole and small group settings, as well as for individual instruction. Teachers utilized the application's accompaniment tracks, method book studies, and concert literature. All three participants mentioned they used the software's assessment features. In regard to barriers of implementation of the program, the teachers all indicated that students often faced financial difficulties in purchasing personal home subscriptions.

In the interviews, the teachers all pointed out the students' level of enjoyment when using the program in the classroom and how SmartMusic® made the learning experience more interactive, which in turn led to improved classroom management. Participants brought up the theme of "student enjoyment" six times and "interactivity" five times throughout the interview process. All three teachers in the study found the application relatively straightforward to use and expressed positive views about its pedagogical benefits in ensembles. Tucker (2016) did not collect any interview data from students directly to back up the participants' claims of their perspectives throughout the study. It would be beneficial to conduct both qualitative and quantitative research focusing primarily on student experiences and attitudes regarding SmartMusic® use in

the future. All teachers in this study indicated that there is a greater need for professional opportunities for utilizing SmartMusic® within ensemble settings.

As technology rapidly improves and expands capabilities within the educational field, teachers must continue to explore best practices of digital pedagogy and how to develop learning experiences that are relevant and engaging to their students. Many of the studies throughout this section highlighted the importance of emphasizing student-centered instructional methods by using technology with composition-based activities (Cremata & Powell; Savage, 2005; Ward, 2009). By introducing activities that broaden students' understanding of music beyond performance, they will start to become more actively engaged in the learning process and take control over their learning experiences (Cayari, 2015). Also, careful consideration of students' personal musical interests will ultimately make music-making more enjoyable and pertinent to their lives (Greher, 2004). Technology presents limitless opportunities for educators to enhance their instruction and further engage students in music. The following section will explore how one-to-one technology programs are extensively broadening and enriching instructional strategies in classrooms.

One-to-one Technology

One-to-one in general education. One-to-one computing programs are becoming a common technology initiative in many educational environments today. According to Beck-Hill and Rosen (2012), these programs often support constructivist approaches to teaching, in which educators emphasize student-centered learning as opposed to direct instruction. Findings have consistently tied constructivist practices to higher student achievement. In addition, when students have greater autonomy in their learning, they often show an increased level of interest and engagement. Approaches to the implementation of one-to-one programs still remains highly variable and understanding specific pedagogical strategies to fully integrate devices into the classroom requires further investigation. While there remains a lack of studies of one-to-one implementation in music classrooms, particularly performance ensemble settings, general education research can help music educators understand how to productively apply these initiatives into their own teaching.

Beck-Hill and Rosen (2012) explored how one-to-one programs cultivate constructivist principles in teaching practices and examined the educational benefits of implementing one-to-one technology strategies in the classroom. Regarding traditional practices, it can be highly difficult to differentiate instruction to cater to all modes of learning and individualize the delivery of content. One-to-one programs, however, can help alleviate these challenges by permitting students to work at their own pace and discover methods of learning that best suit their personal needs. The researchers in the study aimed to compare the impact of one-to-one computing programs to traditional

methods of teaching on reading and math standardized test scores, student attendance, disciplinary problems, differentiated instructional strategies, and learning motivation. They utilized a mixed-method design, analyzing assessment scores, attendance records, student questionnaires, and 55 one-hour observation sessions. The questionnaires were designed to measure students' general motivation in reading and math as well as their attitudes toward learning with computers.

The study was conducted with 476 fourth and fifth grade students and 20 teachers in four elementary schools within a Dallas-area school district. The school district was diverse, with high percentages of black and Hispanic students. The schools selected for the study were relatively similar demographically and had shared characteristics between both students and teachers. Two of the schools were used as the control group, in which teachers maintained traditional teaching approaches, and the two schools within the experimental group implemented a one-to-one program utilizing a pedagogical technology tool called Time to Know. This provided students with various applications that included practice exercises, games, and mixed multimedia presentations. The tools helped teach skills in math, ELA, reading, and writing. Teachers were thoroughly trained in using the program prior to the beginning of the school year and continually monitored and supported by instructional coaches over the course of the study.

Beck-Hill and Rosen (2012) examined both quantitative and qualitative measures in analyzing the one-to-one program's overall effects on student learning, particularly those that aligned with constructivist principles. In their observations, they looked for one-on-one teacher-student learning interactions, independent learning, intellectual

challenge, teacher modeling, instructional adjustment, and feedback. Quantitative results demonstrated that students in the experimental group, after a yearlong participation in the one-to-one program, showed higher gains in the Texas Assessment of Knowledge and Skills in both reading scores (M = 621.9 compared with 665.9) and math scores (M = 654.7 compared with 700.6) in comparison to the control group, which showed smaller increases (reading: M = 643.0 compared with 650.3; math: M = 611.6 compared with 660.1). The fifth grade data revealed similar findings; reading gains (M = 652.5 compared with 713.7) and math gains (M = 654.7 compared with 700.6) in the experimental group were significantly higher than the control group (reading: M = 656.0 compared with 696.1; math: M = 646.4 compared with 674.1). In addition, the one-to-one program also decreased student absences by nearly 30% and disciplinary issues by 62.5%. The researchers did not specify whether other factors may have influenced these statistics.

Based on the teaching observations during the third and fourth months of the study, the results showed much higher one-to-one student-teacher interactions in the experimental group (40.3 interactions) compared to the control group (17 interactions). There were also more instances of differentiated instruction. In general, teacher modeling was implemented more within control lessons (100%), whereas the one-to-one computing program lessons involved a greater level of independent learning (experimental: 100% vs. control: 50%), intellectual challenge (67% vs. 40%), and adjustment of instruction in response to students' interests (83% vs. 30%). Lastly, the measures of the student questionnaire revealed that "students' learning experiences with the program positively

affected motivation to learn math and reading, compared to the traditional settings" (Beck-Hill & Rosen, p. 236).

While much of educational research has found that students' and teachers' perceptions of technology use are often positive, one should consider attitudes of all stakeholders, including parents. Parental involvement can have a significant influence on students' abilities to succeed in school, so teachers and administrators should take into account parents' perceptions of technology use, especially with one-to-one programs in which students have access to devices both in and out of the classroom. Jin and Schmidt-Crawford (2017) explored parents' attitude and perceptions of a one-to-one laptop initiative in a Midwestern high school in order to gain a fuller understanding of how implementation of these programs may benefit or impede student achievement.

The researchers quantitively and qualitatively measured how parents perceived the program both at the beginning and end of the school year and identified what parents viewed as particularly advantageous or concerning regarding the one-to-one initiative. The study occurred during the 2013-14 school year and involved 1,271 students who were distributed relatively evenly between gender and grade level. The district provided all teachers and students in the schools with a MacBook Air laptops, which all students had access to both in the classroom and at home. At the beginning of the school year, parents and teachers were provided orientation sessions to learn about operating procedures and policies. The researchers sent parents a survey during the second week of school and a post-survey near the end of the school year. These were only used in the study if parents responded to both. In total, 205 parents participated, the majority of

whom indicated they had access to both a computer (98%) and Internet (99%) at home. The questions pertained to students' technology use at home and at school, parents' perceptions of the one-to-one program, students' technology skill development, students' change in interest and behaviors, and parents' specific concerns about the initiative.

Jin and Schmidt-Crawford (2017) then identified recurring themes in the qualitative data and calculated descriptive statistics for the quantitative data. Based on the study's pre-survey, many parents expected to see a *positive change* regarding students' behavior and motivation to do schoolwork (52%), interest in classes (46%), interactions with teachers (46%), and grades (31%). However, the survey at the end of the year revealed that fewer parents selected *positive change* for students' behavior and motivation to do schoolwork (37%), interactions with teachers (39%), interest in classes (29%), and grades (21%). However, parents did notice benefits in their children's ability to collaborate with classmates (68%) and better organize assignments (60%). Many parents also believed it was beneficial for students to have access to all their software at home an in the classroom (77%).

Initially, another common concern was that students might lose or break the laptops (49%), or the devices would be distracting when trying to complete schoolwork (42%). After the first year of implementation, parents were less concerned about students damaging the laptop (38%) but had an increased concern about students using the laptops for off-task behaviors, such as socializing (53%). Some participants brought up that technology integration across different classrooms was inconsistent, so ongoing

professional development opportunities for teachers continue to be a vital part in the successful implementation of one-to-one initiatives.

Seeing as parents often have a substantial role in ensuring their children are successful in school, it is imperative that their perspectives are taken into consideration when initiating a wide-scale change to schooling, such as one-to-one programs. These types of programs require buy-in from the community as a whole in order to be implemented as effectively as possible, and teachers and administrators should find ways to support both parents and students in adapting to technological changes.

When planning implementation of one-to-one programs, one should also examine how socioeconomic factors may impact schools' success. Much of the research on technology has found that greater computer and Internet access has increased educational equity and provided invaluable resources for disadvantaged students. Even as technology continues to advance and improve, there are still challenges that some schools must overcome when attempting to introduce one-to-one initiatives in the classroom. Cotten, Farkas, Niiya, Warschuauer, and Zheng (2014) conducted a comparative case study in which they examined one-to-one programs in schools of both high and low economic status and how the programs influenced educational outcomes.

Three school districts, located in Colorado, California, and Alabama, participated in the study. Each of the districts had implemented one-to-one programs in upper elementary classrooms using netbooks and open source software. The schools in Birmingham, AL had predominantly low-SES households with a large population of African American students, whereas the schools in Saugus, CA and Littleton, CO had a

greater number of middle-income households that were primarily white. In the Birmingham district, teachers received only two hours of training on devices, and the teachers within the other districts received ongoing training and mentorship throughout the introduction of the program. Within each of the districts, the primary goal of the one-to-one programs was to improve writing outcomes for students.

Cotten et al. (2014) utilized observations and interviews in conducting the study and took field notes focusing on how the teachers used the devices for writing activities as well as their general attitudes and experiences with the program. Students and administrators were also interviewed over the course of the study, representing a variety of demographics, achievement levels, and experiences using technology. The surveys and interviews were used to get a sense of computer skills, what types of technology were being used, and opinions about the laptop program. Across all schools, the most common use for the laptops was to write and edit papers and 64% of students reported that use of the devices improved the quality of their writing. At a school in Littleton, laptops enabled students to participate in writing activities that were more collaborative and interactive, and having the ability to post their work for the their peers to review motivated them to do well on their assignments. Students and teachers pointed to the increased efficiency that laptop use provided in getting immediate feedback throughout the writing process, which in turn gave them more confidence in their abilities to improve.

In the Birmingham school district, due to lack of Internet access within many classrooms, 20% of students reported that they never used the laptops in school and 60% only used them a little. Typically, students would have to exit the classroom in order to

get wireless access. Because of the lack of the appropriate infrastructure to implement the program, teachers and students had difficulty using the laptops effectively for learning purposes. For their program, parents were expected to maintain the students' laptops themselves, which presented additional challenges due to the schools' low-SES status. This influenced teachers' abilities to integrate the one-to-one program compared to the other school districts.

The study revealed that in order for one-to-one computing programs to be beneficial for both students and teachers, the needs of all stakeholders must be addressed in the planning stages. When relying on the technology alone, teachers may encounter substantial difficulties in incorporating digital pedagogy in their curriculum. Educators must be aware that certain technical limitations may exist when a one-to-one program is implemented, and they must be able to advocate for sufficient resources and professional development opportunities before the program is implemented in order to be successful.

Despite generally positive perspectives and outcomes in regard to one-to-one technology usage in schools, a study by Larwin and Williams (2016) found that these initiatives do not significantly affect achievement in math, reading, science, social studies, and writing skills. In their study, they aimed to determine how one-to-one computing environments affect student achievement in various content areas and how demographics, devices, and longevity influence the impact of one-to-one programs. The study utilized data from 24 high schools in Ohio, all which had implemented one-to-one programs with sophomores for at least one year. Each of these schools was paired with a

non-one-to-one school in the same district that was the most similar based on factors such as demographics, enrollment, and socioeconomic status.

The researchers retrieved Ohio Graduation Test assessment data from online databases on the Ohio Department of Education website. They used an interrupted time series (ITS) design to compare student performance on the state assessment several years before the deployment of the one-to-one program and several years after. Analysis revealed that there were no significant differences in overall achievement between the treatment and control groups ($p > .05$), which also applied within all five content areas. In analyzing demographic subgroup data, the results revealed that the treatment group scored higher than the control group within the Hispanic subgroup but the Black subgroup had opposite results. Performance was similar in the White subgroup between the treatment and control groups. There were no statistical differences based on gender or for IEP students . Therefore, demographics did not have a significant affect on results of the one-to-one programs.

One-to-one in music education. As school districts continue to expand and enhance their technology initiatives, teachers face the issue of how to effectively implement these new technological resources within their curriculum. Schools' implementation and application of one-to-one computing environments are widely variable, so teachers' experiences using devices in the classroom are often rather inconsistent and heavily influenced by a multitude of factors. In order to gain an understanding of how music teachers integrate one-to-one technology within their programs, Dorfman (2016) investigated instructors in a variety of music teaching

environments who utilized these technologies. The researcher sought to identify participants' perceptions of music technology usage as well as their predominant concerns in incorporating one-to-one programs. Using the Concerns-Based Adoption Model (CBAM) as a theoretical framework, which outlines common types of concerns in applying new innovations, the researcher conducted a multiple qualitative case study to examine four music teachers' experiences in integrating one-to-one technology.

The researchers' guiding questions were: "(1) What music education goals can be most effectively supported through the use of one-to-one technology programs? (2) What are music teachers' primary concerns about the implementation of one-to- one technology programs as they affect both their classrooms and their schools? (3) To what extent do music teachers integrate one-to-one technology programs into their teaching, and what factors influence them to do so? and (4) What do music teachers cite as changes to one-to-one technology programs that could be beneficial to their students and to their teaching?" (Dorfman, 2016, p. 162).

The participants had a range of 10 to 20 years of teaching experience and taught a variety of age groups. Most of the observations occurred in elementary general music environments, though one of the observations was in an instrumental music setting. Over the course of six months, the researcher communicated with the participants through e-mail, videoconferencing, and in person. In addition, he conducted three to four observations within the teachers' classrooms. Through these observations and a series of interviews based on the CBAM, the researcher organized the data into a priori codes based on themes that emerged throughout the process.

A commonality from the interviews revealed that much of technology use was for administrative purposes rather than to support musical objectives within the curriculum. Technology was frequently used to document student work and develop portfolios. One participant pointed to the benefits of utilizing devices for composition and arranging activities. Also, a participant explained benefits of using technology to distribute class materials digitally rather than relying on printing. However, Dorfman (2016) found that implementation of one-to-one technology programs widely differed between schools, and teachers reported that technology decisions within the schools were often determined by administrators. Therefore, the success that music teachers had with technology was largely influenced by the school-wide adoption plan as a whole, and two participants expressed concern that they had difficulty installing and managing applications, as this required them to set time aside to work with the students' regular classroom teachers. Participants also discussed issues regarding reliability of technology, identifying problems such as wireless speed or various technical mishaps that ultimately wasted classroom time. Teachers also found difficulty in meaningfully applying technology to musical performance within ensembles.

A clear limitation of this study is that it was conducted with only four participants and the researcher was primarily focusing on concerns that teachers had with one-to-one technology programs rather than investigating the overall benefits. Also, before their observations, the teachers were aware of the exact purpose of this study, so this would have likely influenced their lesson planning and teaching strategies. It would be beneficial to explore how or if teachers normally use technology within their classrooms

in one-to-one programs. Many music teachers often feel more comfortable with traditional models and approaches to music instruction, but as technology proficiency increases and usability improves, adoption of one-to-one technology will likely increase throughout the coming years (Dorfman, 2016).

As noted in multiple interviews in the study, student-centered learning was a central strength of technology implementation in the curriculum. It allowed students to have a greater sense of agency in their learning and discover information related to their personal interests. Dorfman (2016) emphasized that student-centered practices promote social interaction and collaboration and sets up an environment in which students are actively engaged.

These studies demonstrate a wide range of findings regarding the implementation of one-to-one technology initiatives in schools. As schools continue to adopt these programs into their curriculum, it is imperative that educators and researchers continue exploring their potential applications and limitations. The effectiveness of one-to-programs has shown a great deal of variability, so further studies must continue to examine instructional strategies and external factors that influence implementation of one-to-one in the classroom, both short- and long-term. Music education research studies in this area are heavily lacking. Therefore, the present study aims to further explore pedagogical applications of one-to-one technology in music, particularly secondary band programs.

Summary

The use of educational technology presents many advantages as well as limitations for teaching and learning. This review of related literature presented an overview of TPACK (Technological Pedagogical Content Knowledge) as a conceptual framework to understand the ever-expanding intersections between technology, pedagogy, and content. Many music educators still lack proficiencies within the domain of technological pedagogical knowledge (Bauer, 2012), which may be due to insufficient educational technology training in preservice programs (Bauer & Dammers, 2016). Developing a comprehensive understanding of the TPACK domains can help improve teachers' abilities to effectively integrate technological tools in instruction (Divaharan & Koh, 2011).

As music technologies continue to expand and evolve, researchers have investigated specific instructional methods utilized within technology-based music classes. These classes have effectively increased opportunities for students from non-traditional music backgrounds to meaningfully participate in music-making in schools (Dammers, 2012; Williams, 2011). Several studies have pointed to the benefits of using technology for music composition activities (Davis et al., 2011; Savage, 2005; Ward, 2009). In these studies, students appreciated the instantaneous auditory feedback that technology provided while composing. They also enjoyed having the opportunity to freely explore sounds and create music that resonated with their personal stylistic preferences (Cremata & Powell, 2017). While much of the research in music education technology pertains to composition-based projects, a study by Tucker (2016) assessed the uses of SmartMusic® in secondary band ensembles. The researcher found that teachers

expressed positive views on the program's ability to make the learning experience more interactive through its performance and assessment features.

Finally, a more recent development that largely expands the possibilities of technology integration in classrooms is one-to-one computing models. These programs increase opportunities for teachers to differentiate instruction and foster collaboration (Beck-Hill & Rosen, 2012; Jin & Schmidt-Crawford, 2017). However, as with any technology initiative, contextual factors can heavily influence the success of these programs. Within music education, there is still a significant lack of research regarding use of one-to-one technology programs. Dorfman (2016) found that one-to-one devices were used for composition and arranging activities, distributing class materials, developing portfolios, and documenting student work. Many music teachers continue to feel more comfortable using traditional methods of instruction in their classes. However, Dorfman asserted that one-to-one technology adoption within music classrooms will increase as accessibility and usability continue to improve in the future.

Chapter 3: Methodology

This chapter describes the methodology used for the present study, including information regarding the participant selection process, gaining access to the site, and details about the school, participant, and initial visit. In addition, there is a description of the procedures for gathering and analyzing data, including triangulation methods used to ensure data accuracy and reliability. The method and design are modeled after a multiple case study by Dorfman (2016), which explored one-to-one technology implementation in a variety of music classroom settings as well as teachers' perceptions and concerns regarding one-to-one programs. This study was designed as a single intrinsic case study focusing on one-to-one technology use within the context of a middle school music program. To protect participant anonymity throughout the chapter, I will use the pseudonyms Carson for the music teacher and Twisting Pine Middle School for the school.

Research Overview and Questions

The study was a single intrinsic case study that identified teaching approaches involving one-to-one technology within a middle school music program. Case studies investigate "a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information…and reports a case description and case themes" (Creswell, 2007, Kindle Location 2157). Researchers examine participants within natural settings to gain a thorough understanding of a particular phenomenon which begins by identifying cases

that fit within specified parameters based on the research questions. The research questions I aimed to address in this study included:

- How does the teacher apply one-to-one technology in his program?
- How has one-to-one technology improved his teaching approaches?
- How does one-to-one technology support his educational philosophy?
- What factors support or inhibit his use of one-to-one technology?
- How does the role of one-to-one technology in the teacher's instruction relate to the Concerns-Based Adoption Model?

To begin the process, I identified a band program in which one-to-one technology was extensively embedded into the curriculum. I chose a single intrinsic case in order to gain an understanding of how digital applications and tools could best be used to enhance students' experiences in music. Creswell (2007) states that an intrinsic case "illustrate[s] a unique case, a case that has unusual interest in and of itself and needs to be described and detailed" (Kindle Location 2182). Through a series of seven 49-minute classroom period observations and two interviews, one 45 minutes and the second 20 minutes, I explored how the participant regularly applied a variety of technology tools to supplement his curricular objectives. Being an exemplary model, his uses of digital applications and tools can help other music educators determine how they might use one-to-one programs in their own classrooms.

Participant Selection and Gaining Access

In order to select a participant for the study, I used both purposive and convenience sampling. Purposive sampling is often used in qualitative research to find

"individuals and sites for study because they can purposefully inform an understanding of the research problem and central phenomenon in the study" (Creswell, 2007, Kindle Location 5673). Convenience sampling is when a case is selected because it is relatively easy to access for the researcher (Huberman, Miles, & Saldaña, 2014, p. 32). Being that I conducted the study while taking classes full-time, convenience sampling was necessary in order to complete the research in a timely manner.

Initially, I began the process by asking colleagues about instrumental music teachers they have observed who utilize one-to-one technology in their classrooms. Fortunately, the process was fairly straightforward, as I quickly found Carson at Twisting Pine Middle School who had an extensive amount of information about his teaching online. He maintained an active blog and Twitter account that discussed uses of technology in music education, and I discovered that he gave professional development workshops around the state pertaining to one-to-one technology as well. In addition, I found a video interview in which Carson discussed his general teaching philosophies and provided some background information about his band program. He also talked about technology applications that he found beneficial in his classroom. Based on these artifacts, Carson seemed like an ideal candidate to contact for purposes of this study. I obtained approval of recruitment and study information materials (see Appendix A and B) by Indiana University's Institutional Review Board to send to him and other potential participants, if needed.

The process of getting these materials approved by IRB took approximately one month. Because the study involved interviews with the teacher alone as well as non-

participatory classroom observations, it was exempt from further review. Upon gaining exempt status, I sent the recruitment e-mail to Carson. Carson agreed to participate and the school's principal approved his participation in the study.

Information about the Site and Participant

Twisting Pine Middle School was located in a large middle to upper-middle class suburb in the Midwest and had a study body of approximately 900 students. Based on data from the state's Department of Education, the school demographic was approximately 86% white, 5% Asian, 5% Hispanic, and the remainder of the population was comprised of African American, American Indian, and multiracial students. Approximately 16% of students in the school qualified for free or reduced lunch. According to standardized assessment data from the state, the school was relatively high-performing, with 73% of students passing the statewide English and Math exams for the 2017-18 school year.

In the school's band program, there were approximately 220 students enrolled, and the school had roughly 800 students in total involved in either band, choir, or orchestra. All students were required to participate in an ensemble in sixth grade, and if they chose to opt out after the first year, they were required to take an additional semester of general music in seventh grade. For sixth grade, the band program had one brass class and one woodwind class. During the first semester, the seventh graders were divided into two groups: one full band and a Response-to-Intervention (RTI) class which was designed to assist students who were of a lower performing level. The RTI class met first

semester only and combined with the full group in second semester. There was one band in eighth grade.

Carson had been using one-to-one technology in his classes since 2015, when Twisting Pine Middle School implemented its iPad program. Since then, he had found numerous methods to incorporate technology into the students' daily classroom routines, and he worked extensively with the music department in ensuring that digital resources were utilized across all classes. The district was well-known for its various technology initiatives, and teachers were very well-supported and encouraged in their use of technology. Outside of the classroom, Carson participated in and gave many professional development sessions at universities and state music conferences relating to one-to-one technology. In addition, he maintained a blog that discussed technology in addition to many other topics related to music teaching.

Initial Visit

In order to meet Carson and gain a sense of how the music program utilized one-to-one technology, I visited the school and observed three music classes near the end of the fall semester. I wanted to begin establishing rapport with Carson and observe a few of his instrumental ensembles before starting formal observations and interviews. The purpose was simply to familiarize myself with the participant and the music program and to see how the students used one-to-one technology in their normal routines. It helped me feel more comfortable in the setting and gave me an initial idea of the types of activities I might see in future observations.

The first class I observed was a joint rehearsal between the school's orchestra and choir for a piece that they were preparing for their holiday concert. Overall, it was typical rehearsal, but one unique aspect I noticed was that students in the choir were reading the music on their iPads. Carson mentioned that the choir teacher occasionally distributed music this way so students would have easy access to the music outside of school.

The other two classes I observed were band classes. Carson projected the day's procedures in front of the room so the students were aware of what they needed to have ready for the rehearsal. Both classes began with a short note-reading quiz that the students completed on their iPads through Canvas, which was the school's online Learning Management System. The activity was designed as a classroom competition, so students tried to get through the note-reading quiz as quickly as possible. Canvas informs teachers how long it takes a student to complete a quiz, so this helped Carson keep track of which students were still struggling with the activity.

When I talked to Carson in between classes, he remarked that all the music teachers used Canvas regularly to assess students in the program. At the end of each semester, the department administered a cumulative exam to determine students' level of proficiency in several areas of music theory and aural skills. At the beginning of the following semester, they used results of the exam to divide all the music classes into different groups based on students' areas of weakness, whether it was identifying notes on the staff, reading and aurally recognizing rhythms, or defining musical vocabulary. Each of the teachers focused on a specific area, and over the course of a few days, they reviewed these concepts with the students and tried to improve their understanding.

Carson said that using this system of assessment for all the music classes ensured consistency in curriculum and fostered collaboration within the department.

In the band classes, Carson also used an application called TonalEnergy Tuner for the scale warm-up activities. Every student placed their iPad on their stand to evaluate their intonation and visually analyze their sound production. He projected the application on the screen in front of the class for students to see the intonation of the band as a whole, and the students discussed how they could adjust their playing to make intonation and tone quality more consistent. The students were familiar with this procedure and it certainly had an impact on the group's overall sound quality in the warm-up. After students completed their quizzes and warm-up, they worked on concert music for the remainder of the class period.

Visiting the site before beginning the formal interview and observation process was very beneficial in helping to familiarize myself with the school and participant. I was able to gain a sense of the general structure of the classes and how Carson integrated the one-to-one program in his rehearsals. Overall, I could tell that the bands, choirs, and orchestras performed at a very high level. It was interesting to hear about the collaborative efforts the music department made to ensure that their curricula were consistent between the different areas and how students were held accountable for meeting the department's shared objectives for music theory and aural skills. The visit helped me to revise and expand my interview protocol and to develop ideas for data analysis.

Instrumentation

The study utilized semi-structured interviews, which allowed for flexible dialogue between myself and the participant as topics or themes of interest emerged from his responses (DiCicco-Bloom & Crabtree, 2006, p. 315). Additionally, using a semi-structured approach granted me the opportunity to have the participant either clarify or expand on his responses as needed (Stake, 2010, p. 95). The interview questions were based on the two dimensions of the Concerns-Based Adoption Model (CBAM): Stages of Concern (SoC) and Levels of Use (LoU) (Hall, George, & Rutherford, 1977; Hall & Hord, 2001). CBAM is a commonly used theoretical framework for investigating implementation of new innovations in schools and other organizations. The questionnaires for CBAM are used to identify what particular stages teachers fall within. For this study, I used the questionnaires to develop interview questions and codes for analysis.

The CBAM Stages of Concern dimension "provides a way for researchers…to assess teacher concerns about strategies, programs, or materials introduced in a school," which can help determine "the extent of implementation and/or guide teachers successfully through the change process" (Hall, George, & Stiegelbauer, 2006, xi). The Seven Stages of Concern About an Innovation are outlined as follows: (0) Unconcerned; (1) Informational; (2) Personal; (3) Management; (4) Consequence; (5) Collaboration; and (6) Refocusing (see Appendix C). It was evident based on my initial observations and conversations with the participant that he fit many of the descriptors of the higher stages (four and above). In lower stages, teachers have less familiarity with new innovations and

do not necessarily consider their long-term pedagogical uses. Some teachers in the lowest stages may have no desire to change their current practices, or they may have too many concerns about factors that would inhibit them from integrating the innovations.

For the participant in this study, he used one-to-one technology in his instruction for several years and was highly aware of how it impacted student learning. As described in Stages 4 and 5, the participant in the study "[focused] on the innovation's impact on students" in addition to "coordinating and cooperating with others regarding use of the innovation" (p. 8). He continuously sought methods to better implement the innovation in his teaching and extend students' traditional experiences in music ensembles. He regularly participated in professional development related to music technology, which falls under Stage 6 of SoC — "exploring ways to reap more universal benefits from the innovation" (p. 8).

The CBAM Levels of Use dimension focuses on behaviors of individuals in implementing a new innovation, which are categorized as: (0) Nonuse; (I) Orientation; (II) Preparation; (III) Mechanical Use; (IVA) Routine; (IVB) Refinement; (V) Integration; and (VI) Renewal (see Appendix D). Dirksen, George, and Hall (2006) explain: "Whereas SoC addresses the affective aspects of change, such as people's reactions, feeling, perceptions, and attitudes, LoU focuses on behaviors and shows how users are acting with respect to specific change" (p. 1). Much of the analysis for this study will focus on this particular dimension. Again, the participant fits many of the descriptors of LoU Stages 4 through 6. He "varies the use of [one-to-one] to increase the impact on [students]" (Stage 4), "[uses] the innovation with the related activities of

colleagues" (Stage 5), and "examines new developments in the field" (Stage 6) (Hall, George, & Stiegelbauer, 2006, p. 5). A key objective of this study was to examine how the participant's teaching strategies using one-to-one technology related to the dimensions of CBAM.

Interviews

The interview questions are primarily adapted from the Concerns-Based Adoption Model questionnaires. The following specifies which dimensions are addressed for each question (*LoU* = Levels of Use; *SoC* = Stages of Concern).

Initial interview (45 minutes).

1. How extensively do you use 1:1 technology in your classes? (i.e., average amount of class time, number of times per week) (*LoU*)
2. What musical goals and objectives do you feel can best be supported through the use of 1:1 technology? (*LoU*)
3. What factors have enabled you to successfully implement 1:1 technology in your classroom (school-level, district-level, administrative support, parental support)? (*SoC*)
4. How have your approaches evolved from the initial adoption of 1:1 to now? In what ways have you modified and refined your instructional practices? (*LoU*)
5. Are there any notable challenges you have encountered throughout the district's 1:1 adoption process? (*SoC*)

6. In what ways could the 1:1 program be changed so that it could be of greater benefit to you and your students? (*LoU/SoC*)
7. How have you collaborated with other music teachers in integrating technology into the program? (*LoU*)
8. In what ways, if any, does student feedback influence your curricular decisions in regard to 1:1 (e.g., using applications they have suggested)? (*LoU/SoC*)
9. Have you worked with administrators in improving the 1:1 program for your school? If so, how? (*LoU*)
10. What types of applications might you like to see developed in the future that would enhance students' musical experiences in your classroom? (*LoU/SoC*)
11. What professional development (either music or non-music related) have you attended or given regarding 1:1 technology? (*LoU/SoC*)
12. How does using one-to-one technology in your classroom relate to your educational philosophy? (*LoU*)

Final interview (20 minutes).

1. What are some of the strengths of the technology applications you use with your music classes? How do these applications of technology help support your curricular objectives? (*discussed Canvas, TonalEnergy Tuner, GarageBand, Notability, YouTube, Spotify*)

Interview and Observation Procedures

After the initial visit, I explained to Carson that I would begin the process of formal observations and interviews the following semester. The initial interview took place at the beginning of February in his office at Twisting Pine Middle School and was 45 minutes in length. The interview began with introductory items to get an idea of the teacher's educational and professional background (see Appendix E). I then proceeded to ask the questions outlined in the previous section. This interview was audio recorded and transcribed shortly thereafter.

Three observations occurred over a four week period beginning in mid-February. For all visits, I observed a seventh grade general music and a seventh grade band class, which were both 49 minutes in length. On the second visit, I additionally observed an eighth grade band rehearsal. The two seventh grade classes occurred back-to-back, followed by a short lunch break, then the eighth grade band. The seventh grade general music class had 22 students enrolled, the seventh grade band class had 60 students, and the eighth grade band class had 34 students.

Originally, I was not planning on observing the general music class because I was initially interested in how the teacher was using one-to-one technology in his instrumental music classes. However, after the initial interview and further discussion with Carson, I found that observing the general music class would yield useful data, because the course was almost entirely technology-based and primarily involved project-based learning activities. Though much of what he does with this class was not done in his instrumental music classes, the class provided more insight into uses of one-to-one

within the music program. The class introduced students to aspects of music theory, history, listening, composition, and improvisation. The broad curriculum provided multiple opportunities for Carson to utilize a variety of technology resources.

Throughout the observation process, I was a passive participant — "present at the scene of action but [not participating or interacting] with other people to any great extent" (Spradley, 1980, p. 60). I was initially introduced to the students as an observer from Indiana University, and they were given no information as to what I was researching specifically. Students did not interact with me over the course of the observations. In order to be as unobtrusive as possible, I sat behind the students to ensure that my presence did not affect the classroom environment, I took field notes on a personal laptop, organizing them into columns: one side described teaching events that occurred throughout the observation and the other specified any personal questions, thoughts, or interpretations that might help inform my analysis of the data. The descriptive notes summarized the "flow of activities in the classroom," and the reflective sections included notes about "the process, reflections on activities, and summary conclusions about activities for later theme development" (Creswell, 2007, Kindle Location 3362). All observational data were clearly labeled with the date, time, and location, as well as the classes that were observed.

In these observations, I was specifically looking at the participant's teaching strategies that utilized one-to-one technology, whether it involved him using his personal device or the students using their devices. I noted the applications he and/or his students used throughout the lesson and their pedagogical purposes. I wrote observations on the

sequence of the lesson and how technology was used to supplement the lessons' objectives. I noted the physical layout of the room and how the technological devices were set up (e.g., projector, sound system, iPads, personal laptops).

Following the final visit, I conducted an interview that was 20 minutes in length, which included questions regarding specific pedagogical strategies observed throughout the observations (see Appendix E). This interview was audio recorded and transcribed. To triangulate both the interview and observation data, I was granted access to the classes' Canvas pages, which allowed me to collect and examine any pertinent curricular resources, such as digital assessments, presentation slides, online resources, videos, etc. Stake (2010) posited that "evidence that has been triangulated is more credible" and "may make us more confident that we have the meaning right" (p. 123). The participant had a substantial amount of digital resources available within Canvas that he used with all of his classes. Having this information available was valuable in gaining a broad scope of the curricular objectives that one-to-one technology helped facilitate.

Methods for Analysis

Throughout the interview and observation process, I repeatedly reviewed the data to identify codes, which Saldaña (2013) defines as "[words] or short [phrases] that symbolically assign a summative, salient, essence-capturing, and /or evocative attribute for a portion of language-based or visual data" (p. 3). Following each interview and observation, I wrote analytic memos to reflect on my initial thoughts about the data. Analytic memos can be approached either formally or informally, giving the researcher the opportunity to formulate initial ideas about various aspects of the study, including the

research questions, emergent themes, connections to theories or conceptual frameworks, and future directions for the research (Saldaña, 2013, p. 42).

For the coding process, I began by devising deductive codes: "a provisional 'start list' of codes prior to the fieldwork that comes from the conceptual framework, list of research questions, hypotheses, problem areas, and/or key variables that the researcher brings to the study" (Huberman, Miles, & Saldaña, 2014, p. 81). These codes were derived from my initial informal visit to the site as well as key descriptors from the Concerns-Based Adoption Model. For the majority of the analysis, I determined inductive codes, or "codes [that] emerge progressively during data collection," over the course of the interviews and observations to identify additional themes related to the study's research questions (Huberman, Miles, & Saldaña, 2014, p. 81). Throughout the coding process, I primarily employed descriptive coding, which "summarizes in a word or short phrase…the basic topic of qualitative data." (Saldaña, 2013, p. 88). Additionally, I utilized in vivo codes which refer to "a word or short phrase from the actual language found in the qualitative data record" (p. 91). After compiling a full list of codes, I identified those that were most pertinent to the study's research questions and organized them into various categories and subcategories for analysis, which are presented in the following chapter.

Chapter 4: Analysis of Data and Results

In this chapter, I discuss analysis of the data and results I gathered through interviews, observations, and artifacts over the course of the study. They are presented according to to the research questions, which included:

- How does the teacher apply one-to-one technology in his program?
- How has one-to-one technology improved his teaching approaches?
- How does one-to-one technology support his educational philosophy?
- What factors support or inhibit his use of one-to-one technology?
- How does the role of one-to-one technology in the teacher's instruction relate to the Concerns-Based Adoption Model?

I begin with a brief overview of Carson's classroom setup and his technological resources. I then examine the digital tools Carson used throughout my observations. The primary applications used in his band classes were Canvas, TonalEnergy Tuner, and Notability. In his general music class, the primary applications used were Canvas, GarageBand, Google Slides, and YouTube. In addition, I explain the factors that have supported or inhibited the use of technology throughout the school's adoption of the one-to-one program. I conclude with an analysis of how the data relates to the Concerns-Based Adoption Model and how the participant's use of technology coincides with the framework.

While conducting the observations and interviews, I generated a list of approximately 150 hundred codes using the descriptive and in vivo coding methods outlined in the previous chapter. From this initial list, I identified categories and

subcategories of emergent themes and organized these according to the research questions (see Appendix F). In order to present the codes in a clear and consistent manner, the first part of the chapter is divided by each of the applications that were used in the band and general music classes and identifies the most salient themes related to each of these applications.

With his band classes, the notable themes that emerged in relation to his use of Canvas were *informal assessment*, *differentiation*, *music literacy*, and *collaboration*. Ideas and activities related to these themes arose multiple times throughout my observations and interviews. In regard to Carson's use of TonalEnergy Tuner, a recurrent theme was *visualization*. This application was used in each of my observations and was regularly projected at the front of the room in order for students to get a clear visual of their intonation and sound production (e.g., articulation, dynamic changes). With Notability, use of the application related to an important theme pertaining to Carson's teaching philosophy - *autonomous learning*. The students filled out a rubric in Notability to rate their performance at contest. Students in his bands regularly reflected on their playing, and one of his goals as a teacher was to ensure that they were able to recognize and correct mistakes on their own and become more independent in their musical development.

In general music, it was evident that technology drove many of the curricular goals and objectives in the class, such as teaching students about *genre*, *form, chords*, *improvisation*, and *instruments*, which were all themes related to the course's curriculum. These concepts were taught using a variety of applications such as Notability, Google

Slides, and YouTube. As students worked on their GarageBand projects, an intriguing theme that emerged was *exploratory learning*. Though students were provided with clear direction on using GarageBand and structuring their projects, the experience was still open to them learning about the music-making process through trial and error.

In regard to supporting and inhibiting factors of Carson's technology use, a few themes emerged in the interviews. Supporting factors included *funding*, *administrative support*, *tech support*, and *collaboration*. Though the school was clearly well-resourced for technology use, limited *digital literacy* skills and students lack of *Internet access* at home in some cases inhibited their use of technology.

Nonetheless, because of Carson's adequate access to digital resources, his concerns for using technology were quite minimal. He generally fit traits of teachers in the higher levels of the Concerns-Based Adoption Model, which I will explore in the final part of the chapter. Themes were taken directly from the CBAM Stages of Concern and Levels of Use models, which include: *Management* and *Mechanical Use* (Stage 3), *Consequence* and *Routine and Refinement* (Stage 4), *Collaboration* and *Integration* (Stage 5), *Refocusing* and *Renewal* (Stage 6).

Resources and Setup

The one-to-one technology program at Twisting Pine Middle School had existed for nearly four years, and the district had built a highly reliable technology infrastructure and support team to ensure that their teachers and staff could successfully utilize digital resources for their daily instruction. Twisting Pine had a full-time staff member who was dedicated to technology support for the school, and the district's administration as a

whole was highly responsive to teachers' technology needs. Over the course of one-to-one adoption, the district listened to Carson's input regarding implementation of the program. For instance, when the school was debating over the use of iPads versus laptops, Carson argued that he would need iPads in his classroom in order for students to have the ability to place them on their music stands. The music department as a whole was in favor of iPads over laptops, and the administration was willing to listen to their input because they were aware that the music teachers wanted to utilize technology in their programs. As early adopters of the one-to-one initiative, the school supported the music department's technology needs and was willing to work with them on providing any necessary tools they needed for their students.

Hardware. Carson's music room was equipped with several digital resources that enabled him to use technology in a variety of ways. Firstly, the ensemble space was large enough to accommodate roughly 150 students, so having a large screen to project his laptop or iPad was an essential part of the setup. The screen was elevated high in the room so it could be easily seen from any area. Carson mentioned that initially, the screen was low and the projector was on a cart. Given the large space and the standard arrangement of the bands, it was difficult for students to see the screen, so having access to the large, elevated screen provided him the ability to easily project applications for students to view. The projector was connected to Carson's MacBook as well as his Apple TV device, which enabled him to use AirPlay from his iPad. Over the course of his classes, he had the ability to efficiently switch between his devices.

In my first interview with Carson, he mentioned that the overall technology infrastructure was excellent. WiFi outages were very infrequent, and when they did happen, the school was very quick to address the issue. The district regularly tested bandwidth to ensure that the Internet was fast enough to meet teachers' instructional needs. Considering that there were often over one hundred students using devices at any given time within the music department, Internet speed was a critical aspect when using the iPads. The district took the appropriate actions to ensure that the number of students connected to the WiFi did not interfere with Internet speed.

Because Twisting Pine was a one-to-one school, every student had his or her own iPad that they were able to use both in and outside of school. In Carson's classes, students utilized the devices for music theory assessments, concert reflections, practice recordings, composition assignments, and several other activities that will be outlined in the following sections. In Carson's band classes, many students often kept their iPads on their stands to use as a reference point for their intonation with TonalEnergy Tuner. For the general music classes, because the class is heavily technology-based, students often used their iPads for the entire duration of the class period and keep the iPads on their stands or on their laps. Each of the students also had a keyboard that they are able to connect to their iPads, though these were not used in the classes I observed.

Applications

Applications in band. In our initial interview, Carson explained that he used technology almost every day in his band classes, though he specified that he typically only used it for "five to ten minutes a class period…in some way, shape, or form." The

main applications he used were Canvas and TonalEnergy Tuner, and on occasion, he would use applications such as Notability and Padlet. Students regularly used Canvas for informal assessments at the beginning of each class period, which generally involved them reviewing and practicing various music theory concepts. TonalEnergy Tuner was used during ensemble warm-ups as a way to improve the groups' intonation and analyze aspects of their tone production and sound quality. In my final observation, the bands used Notability to complete a self-reflection activity on their state contest performance. Students rated themselves on each of the pieces they performed using an interactive rubric based directly on the judges' rubric, and they submitted their responses through Canvas. Students also saw how each of the judges rated their performance according to the rubric criteria.

Application: Canvas. One of the most important applications that Carson used in his classroom was Canvas, which was the school's online Learning Management System. Canvas had a variety of features that teachers could use to digitally organize materials for their classes. All of the students at Twisting Pine Middle School had a personal Canvas account which they used across all their academic courses, and it had been part of the school's technology ecosystem for nearly four years. Teachers used Canvas to administer assignments, assessments, multimedia, and many other teaching resources. Carson had used Canvas with his students since the school's initial adoption of the application, and he made extensive use of its many features as part of his students' daily routines.

Activities - informal assessment. In my observations, all of Carson's band classes began with a short activity on Canvas before the students started playing. He projected

the day's procedures on the screen in front of the room, and the first step indicated that students had to take a pitch reading quiz on Canvas. These quizzes had twenty questions and students were asked to identify notes in both treble and bass clef. Carson set a time limit of three minutes and students were expected to be able to finish the exercises within that time frame in order to move on to the next exercise, or "Module" as they were called in Canvas. Because Canvas was able to time students, Carson set up a leaderboard at the front of the room to motivate students to complete the quiz as quickly as possible. In the interviews, Carson discussed how students often struggled with note and rhythm reading. Working on these short informal assessments on a daily basis helped his students get consistent practice, and students were able to work at their own individual pace. Once they passed one level in the required amount of time, or "achieved 100% mastery" in Carson's words, they could move on to the next.

Differentiation. Carson expressed that using these activities on Canvas provided him the opportunity to effectively differentiate his instruction and get "instantaneous feedback" on students' progress without having to take the time to grade students' work. He stated, "It's opened my eyes to what I can do to enhance music literacy, rather than just giving a worksheet, passing it out, then finding the time to grade 220-230 papers overnight. It's just not realistic." This was a particularly important theme that emerged in regard to his use of Canvas. With nearly two hundred students in the band program, he discussed that it was difficult to differentiate instruction and to provide students with adequate feedback to improve their musical knowledge. Using Canvas, he and his students regularly received feedback and were able to identify areas of strength and

weakness. Carson could have students retake assessments until they were able to master concepts. Students worked at their own pace but were still given an expectation of where they should be by the end of the semester. He explained that having large amounts of data to analyze on Canvas was extremely valuable in making his instructional decisions and helped him "decide what [students could and couldn't] do."

Curriculum - music literacy. Within the curriculum, Carson primarily used Canvas to support "repertoire comprehension," which he explained was the district's term for music literacy. His Canvas account was set up with various Modules to assist with and assess students' abilities to read notes and rhythms, understand musical vocabulary, and recognize music symbols. Although the classes I observed exclusively focused on pitch reading exercises, there were many additional materials on Carson's Canvas site that afforded students opportunities to practice various aspects of music theory, such as rhythm reading, dynamics, form, and articulations. Carson administered both pre- and post- tests through Canvas that measured their abilities in all these areas. A useful tool that had been created for many of the assessments were Quizlets, which was an online flashcard system designed to help students practice and memorize concepts.

Educational philosophy - collaboration. Another intriguing component to Canvas was how it was utilized within the Twisting Pine music department to collaborate and share resources. Collaboration was a theme that emerged over the course of the interviews, and Canvas was a crucial tool in facilitating collaboration amongst the music teachers. For instance, as discussed in Chapter 3, at the end of the first semester, all the music teachers administered a final exam to students to determine their music theory

proficiency. Based on the exam results, they arranged the students into three groups for one day at the beginning of the following semester, dividing them specifically by the areas in which they needed the most improvement, whether it be pitch reading, rhythm reading, or vocabulary. Though I did not have the opportunity to observe this, Carson discussed how the activity helped him and the rest of his music colleagues ensure that they were taking the time to differentiate instruction for music students across the department. He mentioned he would like more opportunities to conduct these differentiated activities regularly, but it was logistically difficult to analyze the results and divide up all the classes on a regular basis. Over several years, the department had worked together to develop a curriculum that was shared across all the ensembles, and students involved in band, choir, and orchestra were held to the same expectations in regard to their general knowledge of music theory.

Application: TonalEnergy Tuner. In all of his band classes, TonalEnergy Tuner was an application that Carson used on a regular basis. There were several useful features in the application which musicians could easily customize to suit their particular needs. For example, the sound of a sustained tuning note could be set to any instrument, multiple pitches could be held simultaneously, and the range of tuning could be adjusted based on the players' skill level (i.e., wide, medium, fine). Also, the mode of tuning could be set to winds, strings, or voice, which was a feature that was unavailable on most other tuning applications. The metronome feature had numerous selections by which the beat, meter, subdivision, and sound could be customized. Users were able to add multiple presets to save for future use. In addition to the metronome and tuning features,

musicians could video or audio record themselves and analyze the sound wave that was produced while they were playing. Carson utilized many of the features in TonalEnergy Tuner in his instruction and it was an indispensable technology tool in his band rehearsals.

Visualization. The visual aspect of TonalEnergy Tuner was one of the primary reasons that Carson uses the application with his bands. Rather than simply telling students whether they were flat or sharp and asking them to listen more carefully to their peers, the application clearly showed how they needed to adjust their pitch. If they were in tune, it showed players a green smiley face, and if they were out of tune, it showed them a purple quizzical-looking face. As students were playing, they were also able to easily visualize changes in their sound with the "analysis" feature. Unlike traditional tuners, users were able to review how their sound changed over time. Throughout his warm-up activities and for much of the rehearsals, Carson projected TonalEnergy Tuner from his iPad to the screen in the front of the room so students were able to focus on their sound production and recognize when they needed to make adjustments. As they were playing long-tone exercises, the students could determine the accuracy of their intonation and could refer to the sound wave to understand how they were starting and ending each note. For example, students practiced crescendos and decrescendos and Carson asked them if they could see evenness in the growth or decay over time. They could also see how the intonation changed as they got louder or softer. There was an instance when the whole group was sustaining a concert F, and the sound wave revealed clear inconsistencies in sound. Carson stated to the group, "It's not an offensive sound, but it's

not energized. Hold your notes steady." Students were able to immediately respond to the feedback and make appropriate adjustments to their embouchure or air flow to improve the quality of their sound.

Carson indicated that he has heard improvement in the ensemble's sound since using TonalEnergy Tuner. He stated:

> "…it's because they can see what they hear. So, the difference with what I've done before is that I would try to talk to them about – 'your tone, it's trailing off in the end' or 'the front of your notes aren't clean.' Now that I can give them a visual to that, I think it helps them understand – 'you did this, here's what I heard, here's what it looks like, here's how we fix it.' That's been a positive."

Overall, the application served several important purposes in his instruction and was a key digital tool in his daily instruction. Students routinely thought about the quality of their sound and were able to gather immediate feedback through the application.

Application: Notability. During my final observation, Carson used Notability to have his students in band rate themselves on a contest performance that they had given the previous week. He copied a rubric into the application that was similar to what the judges used for the contest, and students rated themselves in the areas of pitch and rhythm accuracy, tone quality, tempo control, articulations, intonation, phasing, dynamics, balance, and blend. Carson used Notability because it gave him the ability to easily share the document with students through Canvas, after which they could mark the rubric with their ratings then submit it back to him. The students selected a different color for each of the pieces they performed and put a dot for where they believed they fell for

each of the aforementioned areas (“Always”, “Usually”, “Often", “Sometimes”, “Rarely”, “Never”, “No Attempt”). On the screen in front of the room, he showed where the judges had rated the group on the scale. The students were able to easily see their strongest and weakest areas and engage in a classroom discussion regarding how they felt about the performance.

Educational philosophy - autonomous learning. One of the most important aspects of Carson’s teaching philosophy was his desire for his students to become autonomous musicians. He explored methods by which he could give students greater agency in their learning and make the process more self-directed. The contest reflection made students think critically about how they could improve in their playing, as well as how their individual performance contributed to the group’s success as a whole. Carson explained that the primary goal of his technology use was “to create an environment where kids learn to be autonomous music-makers.” He had students routinely reflect on their playing in order to achieve this goal.

Applications in general music. Originally, I was not planning on observing Carson’s general music class for the study because I wanted to focus on how technology could be applied within instrumental ensemble settings. However, after discussing Carson’s curriculum in the initial interview, I became intrigued in exploring how this class was structured. It was clear to me that his technology use in general music was quite extensive, so I decided that it would be beneficial to include it as part of the study. The primary application Carson used in these observations was GarageBand. The students were working collaboratively on a Blues songwriting project in which they used the

application to compose a short melody with live vocals, digital guitars, bass, and drums. In the class, Carson also regularly used Google Slides and YouTube to give presentations on the historical context of Blues music. Notability was used for daily student journal entries at the beginning of each class period in which they responded to various questions regarding the topic for the day. Unlike with the band rehearsals, students utilized iPads over the course of the entire class period.

Applications: Notability, Google Slides, and YouTube. *Curriculum - genre, form, chords, improvisation, instruments.* Each of the general music observations began with students answering questions in their Notability journals, called "Minds on Music," pertaining to music that they listened to at the beginning of class. For example, before introducing form to the students, Carson posed the question: "How do you think knowing the form allows for creativity in a song?" After students recorded their responses in Notability, they engaged in a discussion with the rest of the class.

Following this short writing activity, Carson gave a brief presentation on various aspects of Blues music. A few examples of artists students watched and listened to were Stevie Ray Vaughan, B.B. King, and Harry Connick Jr. He prepared presentations using Google Slides in which students were introduced to the 12-Bar Blues form, standard instrumentation in Blues music, and the concept of improvisation. Students were to utilize these ideas in developing their own compositions in GarageBand. He also discussed basic chord structure with the students as they were listening to the recordings. Regarding the various instruments being used in his examples, Carson introduced chordophones, aerophones, membranophones, and idiophones and how the Blues

instruments fit into these categorizations. The two presentations I observed were ten to fifteen minutes in length. The majority of the class period was spent having students work on their GarageBand projects.

Application: GarageBand. Before students began working on their projects, Carson projected the GarageBand application on the screen in front of the room and connected concepts from the presentation to the song-writing process that students would be using for the project. Students were expected to write a song with lyrics and include guitar, bass, and drums as the accompaniment. In addition, one of the sections of the song was to include some form of instrumental improvisation. Before the students began working on their projects, Carson gave them an overview of some of the basic features of GarageBand. He demonstrated how looping worked and showed the SmartGuitar feature. He also demonstrated a basic I-IV-V-I chord progression and explained how they should structure their songs using 12-Bar Blues. The overview was quick and concise, as this project was intended to give students the freedom to explore song-writing methods that worked best for them. Though he provided them with a few specific guidelines on what he expected the students to include in their songs, he emphasized to the class "there [were] no right answers." He encouraged the students to play around with different sounds on the application and adjust the tempo of the music based on the message of their lyrics.

Educational philosophy - exploratory learning. For most of the class period during both of my general music observations, students worked on their projects independently and Carson walked around the room to provide assistance as needed. In

my interviews with him, he discussed the importance of giving students the ability to engage in "creative play." He still scaffolded projects to provide students with a place to start, but he highly encouraged students to be inventive and create "something they [could] be proud of." Generally speaking, GarageBand was a fairly intuitive application and gave individuals with limited musical experience the ability to create music that sounded relatively pleasing. Carson explained that by using the application, "it [was] really hard for them to make it sound bad." As a teacher, he saw the importance in providing the students with structure and guidance in starting them off, but he still left room for experimentation as his students work through the projects.

Supporting and Inhibiting Factors

Throughout the interviews, I aimed to get an idea of what factors helped Carson find success with using one-to-one technology in his program. As mentioned previously, the district as a whole had an extensive support system for teachers using digital resources in their classrooms and were provided substantial professional opportunities to gain confidence in using technology as part of their general curriculum.

Funding and administrative support. Obtaining financial resources to purchase technology was never a significant issue for Carson. For example, early in the program he asked the district to set him up with workstations in the classroom's practice rooms so students could record SmartMusic assessments. Once the administration saw his use of technology, they were more willing to work with him on obtaining additional hardware and software resources that he could use in his instruction. The music department received funding early in the process of the school's technology adoption initiatives

because they expressed that they would be wholly supportive of using the tools in their classes. Carson explained that "the more supportive [the department was] of the initiative, the more supportive [the administration was]." Building this relationship with the administration in the school was a crucial aspect of obtaining the technology tools.

Tech support. Having adequate access to technology support staff in the building was critical in ensuring that teachers were able feel comfortable and confident using digital resources in their classrooms. There was always the chance that teachers would encounter technical issues, and Carson expressed that teachers at Twisting Pine had "instantaneous tech support." If he or other teachers in the department encountered significant issues, "[they would] have a person within minutes to keep [them] up and running." Given that the district developed an extensive base of support at both the school and district levels, there was less of a chance of teachers running into significant issues in using technology. Technology teams regularly conducted bandwidth tests to ensure that WiFi outages rarely occurred. Carson said that there had only been two outages the entire year. Teachers and students did not have to worry about losing Internet access, which could easily disrupt classes that use Internet-dependent applications such as Canvas, Google Slides, and Notability.

Collaboration. The music department at Twisting Pine Middle School made great strides in consistently communicating and collaborating with each other regarding their shared curricular ideas. Digital resources like Canvas enabled them to easily share curriculum materials to ensure students were proficient in their musical understandings based on the level of repertoire they performed. As a department, they worked together to

develop assessments for their students. They provided learning materials that led them to become more musically proficient. With a strong and supportive team who all advocated for technology use with their ensembles, Carson had a reliable support system from which he could obtain useful ideas, training, and feedback.

Digital literacy. Especially with the current generation of students, one would presume them to be fairly capable of using technology tools. Interestingly, Carson expressed that he expected "the kids [to be] more fluent with technology than they really [were]." He mentioned that some students entered sixth grade still having difficulties with navigating iPads and using them in the classroom, despite the fact that many had used one-to-one in their elementary schools as well. The department needed to reconsider how they introduced the students to technology use in their classrooms. Students needed to have a fairly robust set of digital skills in order for them to succeed in Carson's classes, and he stated that "it [was] really impossible to function doing everything [he expected] without technology." By establishing clear and organized classroom routines and having a system like Canvas to keep students organized, he found it possible to increase students' digital capabilities to complete classroom work.

Internet access. Carson mentioned that there were still students at Twisting Pine who did not have access to the Internet at home, which made it difficult for them to complete much of their work at home because many of their teachers assigned work through Canvas. The students who did not have Internet access also found more difficulty using the devices in school, because they were not fully accustomed to navigating iPads. Features that may have seemed more intuitive for many users were sometimes difficult

for those students to figure out, simply because they did not have the equivalent resources at home. Carson pointed out that there were many applications he used that only had pictures and no words. Again, many students understood how to automatically associate pictures and symbols with their respective actions, but there were still students who do not understand what they might mean. Carson stated that in his classroom, it was important to ensure that students without adequate technological access could be "functional in an environment where [they were expected] to use technology." Sometimes it was necessary to take the time to catch those students up with the rest of the class with tasks as common as sending emails, uploading and downloading documents, or submitting assignments electronically.

Concerns-Based Adoption Model: Stages of Concern and Levels of Use

As overviewed in Chapter 3, many of the questions for the interviews and areas of focus for the observations were derived from the Concerns-Based Adoption Model (Hall, George, & Stiegelbauer, 2006). Based on the Stages of Concern (SoC) and Levels of Use (LoU), I examined how Carson's instruction fell within the different stages. Characteristics of teachers within each of of the levels of SoC and LoU are relatively similar, so I will explain how Carson fell within each of the particular categories simultaneously. Because he had been using technology for quite some time and his level of comfort and confidence with technology was generally high, I begin at Stage 3 of the model.

Stage 3 - SoC: Management, LoU: Mechanical Use. Carson had clearly reached a point in his technology implementation in which digital resources were used as a means

to effectively organize and manage his classes, and his technological processes seemed to positively impact efficiency within the classroom. The applications mentioned throughout the previous sections enabled him to have more time to focus on improving his instructional practices, rather than spending time calculating and sorting through students' grades. In terms of learning outcomes, Carson explained that technology like Canvas has "enabled [him] to get back to incorporating music theory and music literacy skills in a way [he] could not do before" because of its ability to instantaneously grade many assignments. He was also able to administer materials more easily by using tools like Google Drive or Notability, and by using these tools, students had an easier time keeping track of their work. Carson said that "organization [was] developmentally difficult" for middle schoolers and "having it all in one place helped [them]."

Stage 4 - SoC: Consequence, LoU: Routine and Refinement. Because Carson had the ability to easily obtain a complete academic profile of his students through Canvas, he could make instructional decisions that were more data-driven. He said that he had a "massive amount of data that [he could] look through and…really decide what [students could and could not] do." By using one-to-one on a continual basis, Carson could frequently experiment with his curriculum in order to meet the learning needs of specific classes or individuals. Within the *Consequence* stage of the CBAM framework, teachers are "concerned about how the innovation affects students" and they evaluate their impact on students (Hall, George, & Stiegelbauer, 2006, p. 27). From the early stages of the one-to-one program, Carson put forth a substantial amount of effort in creating music assessments that would adequately measure his students' musical

understandings and therefore help to identify approaches for increasing their performance abilities within their music ensembles.

Stage 5 - SoC: Collaboration, LoU: Integration. Because this particular theme has been touched on multiple times, there is no need to explore it in further depth. Based on my discussions with Carson, it was clear that being a collaborative colleague is quite important to him as an educator. According to the CBAM questionnaire, teachers in this stage "like to help other faculty in their use of the innovation" and "develop working relationships with both faculty and outside faculty using this innovation." (Hall, George, & Stiegelbauer, 2006, p. 28). Based on my analysis of the interviews and artifacts I gathered, Carson genuinely cared about working with others regarding the use of one-to-one technology in their classrooms, and he enjoyed spreading his technological knowledge and sharing resources in whatever way possible.

Stage 6 - SoC: Refocusing, LoU: Renewal. In general, the data suggested that this was a stage that Carson had not quite reached. Most of the tools he had adopted in his classroom had been used for three to four years. He indicated that he would like to find different approaches in his band classroom that incorporated a greater variety of applications and encouraged a more "exploratory" learning environment. He mentioned that one of his future goals was "being less afraid to try new things" and "[expand] some of [the department's] app use." He had seemed to reach a point where he wanted to "revise the innovation's instructional approach" and "modify [his] use of the innovation based on the experiences of [his] students" (Hall, George, & Stiegelbauer, 2006, p. 28). There was a greater amount of technology use in the general music classes, and Carson

had recently explored the idea of using applications like GarageBand in his band classes. For example, in our final interview, he indicated that one of his students composed a beat that he planned to use during band warm-ups. As part of his learning objectives, he explained that he was "really moving toward trying to get kids to internalize pulse, so maybe the [needed] to have — instead of having the metronome — a beat that [felt] better to them as 12 and 13 year olds." Experimental ideas such as these fall within the sixth stage of CBAM, and at the conclusion of our interviews and observations for the study, Carson expressed that he hoped to find methods to revise and expand his technology use moving forward.

Chapter 5: Summary, Discussion, and Conclusion

The purpose of the this study was to explore applications and pedagogical strategies of one-to-one technology in a middle school music program. The vast amount of technology that is now available for music educators to utilize within their classrooms expands the potential for educational activities that are more collaborative and interactive (Beck-Hill & Rosen, 2012; Cayari, 2015). Digital applications can additionally promote a sense of inclusivity and more opportunities for creative expression in music education giving students freedom to explore the music-making process and to take part in digital music culture (Partti, 2014; Savage, 2005). By using technology, teachers can more effectively differentiate instruction and personalize the learning process for each student (Bassett, Franey, Horsley, McKnight, O'Malley, & Ruzic, 2016).

There is a general lack of research on how one-to-one technology can be effectively utilized for instruction, particularly in music education (Dorfman, 2016). Much of the prior research on music technology has occurred within the context of technology-based music classes (Dammers, 2012; Williams, 2011). It is becoming increasingly important to examine the implications of one-to-one initiatives as districts continue to implement these programs at a rapid rate and put substantial funding into technology resources for schools. Due to the fact that teachers have the ability to use one-to-one devices regardless of the classroom setup, there is substantial opportunity to expand upon technology's use. Teachers can now integrate it into classrooms where it would have previously been logistically difficult, such as large music ensembles. As more schools begin to implement one-to-one programs and teachers are held accountable for

cultivating students' digital skills, it is imperative that teachers find methods by which technology can be used to enhance and improve learning experiences.

Discussion of Research Questions and Implications for Teaching

Research Question 1: How does the teacher apply one-to-one technology in his program? Carson utilized numerous applications within his band and general music classes to support his curriculum and provide students with a more holistic understanding of musical topics and concepts. The primary applications he used throughout the observations included Canvas, GarageBand, Google Slides, Notability, Spotify, TonalEnergy Tuner, and YouTube. The applications served a variety of purposes in his instruction, and they all seemed to have enhanced the classroom experience and made students more engaged in their learning. Each of the applications he used in his music program served specific pedagogical purposes, and instruction of the material would have been much different and in some cases unfeasible without use of these digital tools and resources.

Canvas. The most robust technology tool that Carson used over the course of the study was Canvas, which he used for all his classes to distribute materials, give assignments, and administer assessments. Each of his Canvas pages had an extensive amount of material which helped maintain the structure of his daily activities and make learning outcomes clear to his students. Learning Management Systems such as Canvas are becoming increasingly important within schools, and it is important for teachers to take advantage of these systems in order to keep their classes more organized and make materials easily accessible to students. If teachers upload their course materials to

Learning Management Systems on a regular basis, students are able to have access to assignments and resources from anywhere, and there is less concern over students or teachers losing track of their work. Using Canvas gave students access to the materials they needed whether they were at home or at school.

Notability. Notability was another application that seemed to help students be organized and made it easy to administer materials digitally. One of the primary advantages of using Notability was that the application allows users to mark up many types of file formats (e.g., PDFs, Word documents, web pages, photos, etc.) with a variety of editing tools. Using this application, students had the ability to write, highlight, draw, and create notes which they can share with others. The application gave Carson the ability to have his students do activities such as the "Minds on Music" journals and contest reflection rubrics electronically, which were easily submitted through Canvas.

GarageBand. In general music, GarageBand gave students the opportunity to explore their creativity and compose songs without the need for a substantial amount of instruction or guidance. The application was highly intuitive and user-friendly even for young students, so they were able to explore many of the features on their own without extensive guidance. Students from non-musical backgrounds could create songs that sounded decent within a short time frame which gave them a greater sense of immediate satisfaction in the music-making process.

Google Slides. Carson regularly used Slides to give presentations to his general music class. Rather than simply lecturing to students and having them take notes as he was talking, Carson made the his presentations very interactive. The students would

begin with an open-ended question that they answered in their Notability journals, and over the course of the presentation, he would show various photos and videos that related to the musical topic. They would engage in discussions about what they saw and how it might tie into their personal composition projects. As with many of the previous applications, Google makes it easy to share these presentations with students, so they are able to access them for future reference.

TonalEnergy Tuner. TonalEnergy Tuner has become a very popular tuner and metronome application for musicians to use in practice and rehearsals. The ability to easily customize settings in the application gives users flexibility in how they use it in their practice. This was a particularly important application for Carson to use when working on improving his ensembles' overall tone quality. Often, musicians are not fully aware of how to properly adjust for intonation until they reach intermediate or advanced levels. Introducing the concept early in students' musical development helps establish proper habits for embouchure, articulation, and air flow that they might not grasp as easily without with assistance of the "analysis" feature in TonalEnergy Tuner. Ensemble directors generally spend a substantial amount of time telling their groups to listen for tuning and articulation style, but these can often be difficult concepts for young musicians to understand because they require strong aural skills. Carson discussed how TonalEnergy Tuner has improved the overall sound quality of his bands and having the ability to represent the visual aspect of sound has been a strong benefit of using the application with his classes.

YouTube and Spotify. Most students were familiar with YouTube and Spotify and these applications could certainly serve many pedagogical purposes. Carson liked to provide his students with models of professional players on a regular basis so they were aware of what they should strive for throughout their musical development. With the vast amount of material available on these applications, teachers could provide students with high-quality recordings that represented top musicians in the field who would motivate and inspire them to improve their own performance abilities.

Research Question 2: How has one-to-one technology improved his teaching approaches? One of the most notable ways that technology had improved Carson's teaching was that it gave him the ability to make data-driven decisions in his instruction. Ensemble directors are often reluctant to give their students assessments that measure their understandings of music theory, simply because it can take a substantial amount of time to grade students' work. As opposed to core academic teachers who might have 20 to 30 students in their classrooms, it is not uncommon for ensemble directors to have double that amount. Given the sheer number of students involved in ensembles, finding ways to assess them efficiently is a substantial challenge. This is why Carson gave his students informal Canvas assessments at the start of each class. It gave them the opportunity to practice their theory skills, demonstrate their current level of understanding, and receive instantaneous feedback.

With technology-assisted instruction, teachers do not have to take a "one-and-done" approach to assessing students, rather, assessment can be regular and ongoing. As Carson discussed multiple times in interviews, his goal was to ensure that his students

achieved one-hundred percent mastery of musical concepts. With his Canvas quizzes, students were able to take them as many times as needed until they are able to get a passing score. This made it easier to differentiate instruction and ensure that students who moved at a slower pace can get the guidance they needed, and the students who grasped the material more quickly could move on to more challenging material.

Another significant advantage of utilizing technology in the classroom is the element of visual learning that it brings to lessons. Although the primary mode of learning music is aural, there are many opportunities with music technology to represent music visually. With applications like TonalEnergy Tuner, students gain a better sense of how their sound "looks." As students develop their understandings of tone quality on their instruments, providing a clear visual representation of the sound can be a tremendously valuable way of showing them visual feedback rather than merely relying on verbal direction from the director.

Technology has enhanced the capabilities of engaging students in creative activities. Specifically in Carson's general music class, he gave students a substantial amount of freedom in their music composition projects. Although they had specific guidelines for some general components of their songs, much of what they produced could be personalized to reflect their individual musical interests. Using applications like GarageBand provided students with the immediate satisfaction of creating a song that, generally speaking, made musical sense. Music teachers should consider students' sense of satisfaction when allowing them to engage in exploratory learning involving digital tools. If the technology is too complex, students can easily lose motivation to create

music without any prior understanding of chord structure, rhythm, form, etc. Though there are disadvantages to having students simply drag and drop items in a loop to create music, it nonetheless engages them in the creative process and may encourage them to pursue musical endeavors in the future.

Research Question 3: How does one-to-one technology support his educational philosophy? Technology enabled Carson's students to become more autonomous in their learning. Ultimately, one of his primary goals was to ensure that his students had the knowledge and resources they needed to be able to reflect on their playing and solve problems on their own. Part of his core values as a teacher was to continually discover ways to "learn and grow." Carson maintained a sense of curiosity in his teaching and accepted that he did not have the answers to everything. He regularly reflected on his own instructional practices and explored ways to improve them.

The idea of constantly learning and growing was also a value he instilled in his students. Learning to be a great musician is a process that requires extreme persistence, and one must be able to accept that they must make mistakes and overcome obstacles in order to grow. Learning music is by no means a linear process, and Carson gave his students the guidance and motivation they needed to push through challenges.

Technology provides students with tools to reflect on their playing and to identify ways they can improve. Carson regularly had his students video record their practice, reflect upon their performance, and engage in self-talk regarding the strategies they use, rather than simply giving them an allotted amount of time they needed to practice and requiring them to submit a practice card. The video recordings held students more

accountable for ensuring that their music practice was productive, and Carson used strategies that helped the students meaningfully reflect upon what they needed to do to improve. By doing this from the early stages in their musical development, students learned to become more autonomous and were better able to take charge of their own musical training rather than having to rely exclusively on feedback and input from an instructor.

Research Question 4: What factors support or inhibit his use of one-to-one technology? Overall, Carson had been fortunate to be in a school district that has effectively enabled him to successfully implement the one-to-one program within his classes. When implementing technology in schools, particularly one-to-one programs, there are many considerations that administrators must make before permitting students to use devices on a regular basis. Adequate infrastructure is an incredibly important factor to consider in the roll-out of any technology initiative, because if technical issues arise early in the process, such as WiFi outages, teachers become more wary of integrating technology into their curriculum. Twisting Pine Middle School was part of a district that placed a great amount of care and thought into their technology plans, so teachers were generally able to obtain and sustain the resources they needed to effectively implement digital tools and resources in their classrooms.

Lack of Internet access at home was still an issue that some students faced that made it difficult for them to complete their work. Though I did not find out what steps the school had taken to resolve this issue, it may have inhibited some students' ability to succeed. In addition, even though this generation of students had been using mobile

devices for much of their lives, they still sometimes lacked basic digital literacy skills, particularly when it came to using educational tools. Teachers should not assume that just because students have been using technology for most of their lives that they will automatically know how to easily work with applications. Like with any other skill or concept that teachers introduce to students, they must scaffold their activities, beginning with simple tasks and building up students' skills gradually.

Initially, Carson believed that his students would be more adept at using iPads, but he discovered that he had to take the time to methodically introduce students to the music technology applications. Generally speaking, newer applications are becoming more user-friendly, and there are now many digital resources that are designed for K-12 music students specifically. Devices are also becoming easier to use, so teaching the technology to young students is less of an inhibiting factor when developing one-to-one programs.

Research Question 5: How does the role of one-to-one technology in the teacher's instruction relate to the Concerns-Based Adoption Model? The Concerns-Based Adoption Model is a highly valuable framework in evaluating how teachers implement new innovations in schools. The Stages of Concern and Levels of Use scales provide individuals with a clear idea of the various characteristics associated with teachers' ability to use innovations effectively and accurately determine the support they may need in using the innovation. Teachers in the lower levels of the model will be more hesitant to adjust their methods of instruction to include new resources and tools. Teachers at the higher levels on the scale continually think about how they can use more

contemporary practices to improve their instruction, and they are also dedicated to collaborating with colleagues to gain new ideas and perspectives in employing innovative approaches. Knowing where a teacher falls on the scale is helpful in determining how he or she can be best supported in effectively applying new innovations in their curriculum.

By using the Concerns-Based Adoption Model in this study, I was able to focus my observations and interviews on what made Carson's use of one-to-one technology particularly beneficial. Identifying and observing an exemplary model was an effective approach in determining practical examples that teachers might exhibit within higher levels of the CBAM scales. Carson's goals to improve the way he implemented technology in his classroom demonstrated that he aimed to maximize student outcomes in his classes using innovative approaches. Since he had been using one-to-one devices for several years, he felt comfortable collaborating with others and sharing his knowledge about using technology. He provided professional development sessions to teachers both within and outside of the district to introduce them to new pedagogical methods using technology. He worked with his department to find ways by which technology can be used to align curricular objectives amongst all the music classes. Based on our discussions over the course of the study, Carson came to the realization that although many of his approaches to teaching were unique and innovative, they had remained fairly stagnant over the past three years. He clearly expressed a desire to find new technological tools to continue improving student achievement. This trait represents the highest level of the CBAM Stages of Concern and Level of Use scales, in which individuals hope to

discover more impactful approaches to using the innovations or experimenting with alternatives.

Ideas for Future Research

As one-to-one programs become more commonplace in schools, there will be substantial opportunity for researchers to explore how these programs affect students' musical experiences. Much of the prior research on music technology occurred within computer lab settings. Now that one-to-one programs give students the ability to work on their devices from anywhere, there are tremendous possibilities for students to engage in collaborative and creative project-based activities that would have been less feasible in the past, especially in music ensemble settings. With one-to-one programs, research can extend beyond Technology-Based Music Classes and explore how technology can be blended into more traditional performance-based instruction, like bands, choirs, or orchestras.

Although many of the findings in the present study pointed to the benefits of technology use, the pervasive application of devices may certainly have drawbacks within teaching and learning contexts. Within modern society, many individuals perpetually rely upon personal technology devices both within and outside of work and school environments. Research on how this might be detrimental for students to meaningfully develop collaborative skills with their peers might be beneficial to determine appropriate pedagogical applications of technology in the classroom.

Also, having a greater understanding of students' perspectives of regularly using technology in their learning is an area that requires further investigation, as students'

interactions with various technologies will continually change and evolve. Researchers should determine how technology impacts student motivation in learning both at school and at home. One-to-one technology affords students the ability to access a limitless amount of educational materials, so having a better understanding of how students are utilizing these resources to reach learning goals would be beneficial. Understanding students' interactions with devices within school in comparison to outside of school could be a potential area of interest.

Within the area of music education, technology's impact on student creativity is a topic that needs continual investigation, as there are new music applications being released on a regular basis that allow students to engage with music in highly innovative and creative ways. Music applications continue to have more advanced capabilities with recent developments in artificial intelligence, giving students with limited musical knowledge the ability to create music that sounds enjoyable and gratifying. The benefits and drawbacks of the immediate satisfaction associated with music creation through technology compared to approaching music composition more traditionally could be a potential topic of interest.

Base on my observations of Carson's extensive use of Canvas to assess students, it would be useful to conduct studies on how online Learning Management Systems affect student outcomes in music by analyzing formative and summative assessment data. Music teachers often struggle with finding ways to regularly determine individual student's musical understandings because they sometimes have to single-handedly teach hundreds of children. With the automatic grading feature of applications like Canvas and

Google Classroom, music teachers have an opportunity to make instructional decisions that are determined by assessment data and differentiate their instruction to cater to the learning needs of individual students. In addition, these applications give teachers the ability to easily collaborate and share resources, assignments, and assessments. It would be intriguing to explore how various technology applications can facilitate and encourage collaboration amongst music teachers and students.

Because this study was limited to a single exemplary model of technology use in a music program and involved a limited number of observations and interviews, more extensive studies of one-to-one technology's uses in other music settings is necessary to gain a better understanding of how digital devices can effectively be integrated in the classroom. The school in this study was highly supportive of technology use and provided ample resources to its teachers, so Carson's uses of technology could be more difficult to implement in other environments. Although one-to-one implementation has proven to be successful in Twisting Pine's music program, uses of technology are heavily dependent on the context and teachers' overarching learning goals and objectives.

Lastly, based on the findings of the present study, it was clear that applications of technology were notably different between the instrumental and general music settings. Selecting appropriate music technology applications depending on the specific context is an area that needs greater examination, as different music classes serve varying curricular goals. General music classes typically involve providing students with a broad range of activities that involve performing, listening, creating, and responding to music in variety of ways. Instrumental and choral ensembles often require that teachers primarily focus on

developing students' performance skills, so uses of technology in these contexts are likely often different.

Conclusion

The integration of technology into classroom instruction is imperative in order to provide students with the digital skills that have become an indispensable part of our daily lives. The immense variety of digital resources within education vastly expands the pedagogical possibilities of creating instructional activities that are student-centered, collaborative, interest-based, and creative. In music education, many teachers continue to follow traditional methods and approaches, especially within band, orchestra, or choir ensembles. With the advent of one-to-one technology programs in schools, there is limitless potential to restructure curricula to give students greater opportunity to effectively perform, create, and connect to music in new and innovative ways.

As districts continue to increase their funding for technology initiatives, music teachers must take advantage of the numerous opportunities to use digital learning to enhance their instruction and help students meaningfully engage with music. Music educators can use technology to reach students who may not be interested in being part of traditional ensembles but still have a desire to explore and create music that personally resonates with them. Students from any background should be granted opportunities to enjoy and participate in music in schools, and one-to-one technology largely expands the curricular possibilities within both traditional and contemporary music education.

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APPENDICES

Appendix A: Recruitment Materials

Dear [potential participant],

My name is Loren McCready and I am a Master of Music Education at Indiana University Jacobs School of Music. I am currently researching one-to-one technology use in instrumental music programs and was referred to you by [recommender], who identified your band program as an exemplary case of technology integration in the classroom.

Given your substantial experience with technology in teaching, I would ask that you consider participating in my research. The study would involve an initial one-hour interview and observations of three class periods, with brief 10-15 minute interviews following each observation. More details can be found in the attached Study Information Sheet.

If you have any questions, please feel free to contact me at lomccrea@iu.edu or 719-761-8569.

I appreciate your consideration and look forward to hearing from you soon.

Sincerely,

Loren McCready

Appendix B: Study Information Sheet for the Institutional Review Board

You are invited to participate in a research study of one-to-one technology use in instrumental music programs. The research will be a case study in which you will be the sole participant. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

The study is being conducted by Loren McCready, a Master of Music Education student at the Jacobs School of Music.

STUDY PURPOSE

The purpose of this study is to identify effective teaching strategies utilizing one-to-one technology in an exemplary middle school instrumental band setting.

PROCEDURES FOR THE STUDY:

If you agree to be in the study, you will do the following things:

Initially, you will be interviewed for approximately one hour, responding to questions related to technology use in your classroom. The researcher will base interview questions on a case study conducted by Dorfman (2016), which include the following:

1.What concerns do you have about the use of one-to-one technologies in your school in general?
2.What concerns do you have about the use of one-to-one technologies in your classroom?
3.How extensively do you use the one-to-one technology in your classes?
4.In what ways could the one-to-one program be changed so that it could be of greater benefit to you and your students?
5.What musical goals and objectives do you feel can be best supported through the uses of one-to-one technology?
6.Do you have concerns about time as they relate to 1:1?
7.Tell me about the faculty support and collaboration that goes on around 1:1? Are there resources available for you?
8.How has 1:1 changed your approach?
9.What impacts do you think 1:1 has had on the students?
10.How does 1:1 come full circle in your school? Do you have a chance to evaluate the program, etc.?

Following this interview, we will discuss three class periods to observe in which one-to-one technology will be integrated into your lessons. There will be approximately one week between each visit. For the observations, the researcher will be seated behind the students and no researcher-to-student interaction will occur. You will be asked to make use of one-to-one in these classes as you normally would, and the researcher will take notes regarding pedagogical applications of technology in the lessons. The researcher will not note any student responses or behaviors throughout the observations.

Ten to fifteen-minute follow-up interviews will occur after each visit regarding specific teaching strategies observed throughout the lessons. A recording device will be used to record audio of the interviews. All recordings will later be transcribed.

RISKS AND BENEFITS

The risks of participating in this research include being uncomfortable with the interview questions or having your classroom be observed.

There is also a risk of loss of confidentiality.

You are not expected to benefit from participating in this research. However, as an exemplary music education technologist, reporting your pedagogical strategies could help benefit music educators in the field who are interested in approaches to technology integration.

CONFIDENTIALITY

Efforts will be made to keep your personal information confidential. We cannot guarantee absolute confidentiality. Your personal information may be disclosed if required by law. Your identity will be held in confidence in reports in which the study may be published and databases in which results may be stored. Only the researcher will have access to the audio recordings, and these recordings will be destroyed immediately following his successful thesis defense.

Organizations that may inspect and/or copy your research records for quality assurance and data analysis include groups such as the study investigator and his/her research associates, the Indiana University Institutional Review Board or its designees, or the study sponsor, who may ask to review your research records.

PAYMENT

You will not receive payment for taking part in this study.

CONTACTS FOR QUESTIONS OR PROBLEMS

For questions about the study, please contact the researchers:

Loren McCready
719-761-8569
lomccrea@iu.edu

Peter Miksza
812-855-7253
pmiksza@indiana.edu

For questions about your rights as a research participant or to discuss problems, complaints or concerns about a research study, or to obtain information, or offer input, contact the IU Human Subjects Office at (812) 856-4242 or (800) 696-2949.

VOLUNTARY NATURE OF STUDY

Taking part in this study is voluntary. You may choose not to take part or may leave the study at any time. Leaving the study will not result in any penalty or loss of benefits to which you are entitled. Your decision whether or not to participate in this study will not affect your current or future relations with Indiana University.

Appendix C: The Stages of Concern About an Innovation

IMPACT	**6**	**Refocusing**	The individual focuses on exploring ways to reap more universal benefits from the innovation, including the possibility of making major changes to it or replacing it with a more powerful alternative.
	5	**Collaboration**	The individual focuses on coordinating and cooperating with others regarding use of the innovation.
	4	**Consequence**	The individual focuses on the innovation's impact on students in his or her immediate sphere of influence. Considerations include the relevance of the innovation for students; the evaluation of student outcomes, including performance and competencies; and the changes needed to improve student outcomes.
TASK	**3**	**Management**	The individual focuses on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organizing, managing, and scheduling dominate.
SELF	**2**	**Personal**	The individual is uncertain about the demands of the innovation, his or her adequacy to meet those demands, and/or his or her role with the innovation. The individual is analyzing his or her relationship to the reward structure of the organization, determining his or her part in decision making, and considering potential conflicts with existing structures or personal commitment. Concerns also might involve the financial or status implications of the program for the individual and his or her colleagues.
	1	**Informational**	The individual indicates a general awareness of the innovation and interest in learning more details about it. The individual does not seem to be worried about himself or herself in relation to the innovation. Any interest is in impersonal, substantive aspects of the innovation, such as its general characteristics, effects, and requirements for use.
	0	**Unconcerned**	The individual indicates little concern about or involvement with the innovation.

Appendix D: Levels of Use of an Innovation

0	Nonuse: State in which the user has little or no knowledge of the innovation, has no involvement with the innovation, and is doing nothing toward becoming involved.
I	Orientation: State in which the user has acquired or is acquiring information about the innovation and/or has explored or is exploring its value orientation and its demands upon the user and the user system.
II	Preparation: State in which the user is preparing for first use of the innovation.
III	Mechanical Use: State in which the user focuses most effort on the short-term, day-to-day use of the innovation with little time for reflection. Changes in use are made more to meet user needs than client needs. The user is primarily engaged in a stepwise attempt to master the tasks required to use the innovation, often resulting in disjointed and superficial use.
IVA	Routine: Use of the innovation is stabilized. Few if any changes are being made in ongoing use. Little preparation or thought is being given to improving innovation use or its consequences.
IVB	Refinement: State in which the user varies the use of the innovation to increase the impact on clients within immediate sphere of influence. Variations are based on knowledge of both short- and long-term consequences for clients.
V	Integration: State in which the user is combining own efforts to use the innovation with the related activities of colleagues to achieve a collective effect on clients within their common sphere of influence.
VI	Renewal: State in which the user reevaluates the quality of use of the innovation, seeks major modifications or alternatives to the present innovation to achieve increased impact on clients, examines new developments in the field, and explores new goals for self and the system.

Appendix E: Interview Protocol

Teacher name: _____

Phone Number: _____ Email Address: _____

School district: _____

School: _____

Address: _____

Courses Taught: _____

_____

Number of students in school: _____ Number of students in band: _____

List of degrees held and major areas of study (i.e., Bachelor of Music Education, clarinet)

_____

Years of teaching experience: _____

How long have you been using one-to-one technology in your program? _____

Initial Interview

1. How extensively do you use 1:1 technology in your classes? (i.e., average amount of class time, number of times per week)
2. What musical goals and objectives do you feel can best be supported through the use of 1:1 technology?
3. What factors have enabled you to successfully implement 1:1 technology in your classroom (school-level, district-level, administrative support, parental support)?
4. How have your approaches evolved from the initial adoption of 1:1 to now? In what ways have you modified and refined your instructional practices?
5. Are there any notable challenges you have encountered throughout the district's 1:1 adoption process?
6. In what ways could the 1:1 program be changed so that it could be of greater benefit to you and your students?
7. How have you collaborated with other music teachers in integrating technology into the program?
8. In what ways, if any, does student feedback influence your curricular decisions in regard to 1:1 (e.g., using applications they have suggested)?
9. Have you worked with administrators in improving the 1:1 program for your school? If so, how?
10. What types of applications might you like to see developed in the future that would enhance students' musical experiences in your classroom?
11. What professional development (either music or non-music related) have you attended or given regarding 1:1 technology?
12. How does using one-to-one technology in your classroom relate to your educational philosophy?

Final Interview

1. What are some of the strengths of the technology applications you use with your music classes? How do these applications of technology help support your curricular objectives?

Appendix F: List of Codes

How does the teacher apply one-to-one technology in his program?

Technology resources	*Applications*	• Canvas • Tonal Energy Tuner • Notability • GarageBand • Padlet • YouTube • Spotify
	Hardware	• iPads • HD projector • MacBook • Microphones • Apple TV
Curriculum	*Music literacy*	• Note-reading • Rhythm-reading • Form • Chords • Instruments
	Improvisation	
	Musical genres	• Jazz • Rock and Roll • Pop
	Data-driven decisions	• Immediate feedback
	Developing listening skills	• Critical reflection (group and individual)

How has one-to-one technology improved his teaching approaches?

Philosophy	*"Autonomous learners"*	• "Self-directed" • Student agency • Informal learning • Exploratory learning
	"Learning and growth"	• Self-reflection
	Collaboration	• Departmental • Professional Development
	Creativity	

Motivation	*Immediate satisfaction*	
	Taking pride in their work	
Engagement	*Hands-on*	
	Visualization	• Sound quality (intonation, tone, articulation) • Rhythm • Score analysis
Instantaneous feedback	*Efficiency*	• Grading
	Differentiation	• Informal assessment

What factors support or inhibit his use of one-to-one technology?

Supporting factors	*Funding*	• District • Grants
	Advocacy	• Amount of technology use • Early adopters
	Administration	
	Technical support	• Full-time in-building staff member
	Infrastructure	• Reliable WiFi
	Collaborative department	
	Training and support	
	Classroom management	• Setting up expectations • Students "police" each other
Inhibiting factors	*Students' understanding of technology*	
	Lack of Internet access at home	

How does the role of technology in the teacher's instruction relate to the Concerns-Based Adoption Model?

Collaboration	*Department impact on one-to-one implementation*	• "Unified arts department"
Future Ideas	*Students "curate the curriculum"*	
	"Being less afraid of trying new things	